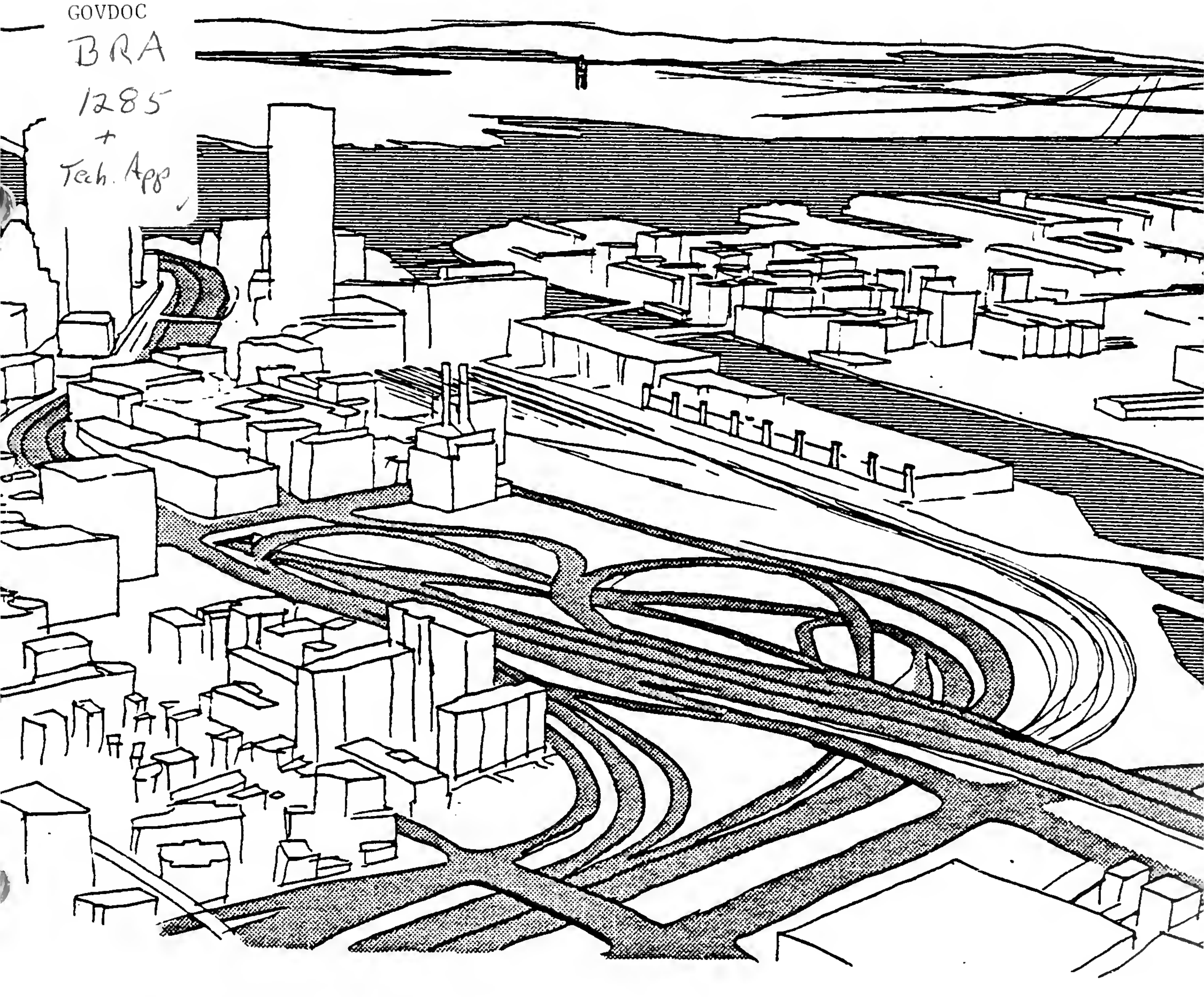
CENTRAL ARTERY / I-93 CORRIDOR

SOUTH AREA PLANNING STUDY



BOSTON, MASS. AUGUST 1978

The Commonwealth of Massachusetts

Executive Office of Transportation and Construction

Department of Public Works

Office of the Commissioner

100 Nashua Street, Boston 02114

August 16, 1978

Mr. Norman Van Ness
Division Administrator
Federal Highway Administration
100 Summer Street Suite 1517
Boston, Massachusetts 02118

Dear Mr. Van Ness:

The attached documents constitute Corridor Planning Studies of the proposed improvements to the Central Artery in the Central and South Areas of the Corridor. The study was undertaken by the Commonwealth to determine feasible corridors and alternatives. Based on the technical work, and following a series of meetings with agencies, individuals and community groups, I find that the projects are feasible and should proceed into environmental impact analysis, for reasons cited in the document.

The focus on the Central Artery has emerged from a decade of examination of local and national transportation policies. This examination has yielded the following:

1. We have moved from a search for new alignments for additional urban expressways to detailed study of how to improve service levels in all modes of transportation.

2. Analysis of the existing highway network has revealed several serious bottlenecks in the system serving Eastern Massachusetts. These must be corrected.

3. Chief among these is Boston's Central Artery, a 2.5 mile stretch of highway that carries more traffic and experiences more accidents than any other comparable stretch in the state. In addition to serving as the sole north-south expressway within Route 128, the Artery connects with Storrow Drive, the harbor tunnels, the Mystic Bridge and the Mass. Turnpike and serves most of the traffic to Downtown, the seaport and Logan Airport.

Because the Central Artery is the predominant road facility in the region, alterations made to it will affect the regional economy of the Boston Metropolitan Area, which is expected to grow by 3.5% per year. For example, if the Central Artery is not reconstructed, and the growth of the regional economy were retarded by as little as 0.1%, the region would permanently lose $1,080,000,000 over the 40-year life of the facility. Obviously, it is difficult to pinpoint this type of figure. The environmental and engineering analysis to be undertaken will attempt to define in closer measure these economic impacts. The lack of improvements to the Artery would potentially mean no growth, with severe negative economic, social and environmental consequences for the region.

Plans to improve the Central Artery have been moved forward in an effort to ensure that this vital link in Eastern Massachusetts' highway network can fulfill its critical transportation function, thereby enabling the region - and particularly metropolitan Boston - to realize the full economic growth potential. This work has been underway for seven years, during which feasibility analyses have demonstrated the problems and potential of the facility. It has been part of a process reflecting local, regional and state growth and development policies, which are mirrored in new federal urban policies as well. I have reviewed these policies below to demonstrate the integral role which Artery improvements have in the continuing development process in Boston and in Massachusetts.

Relation to State Policies

Massachusetts has been a leader in developing state growth and development policies in concert with local communities. These have been defined both by present and past gubernatorial administrations, and also by the joint efforts of the state legislature, municipalities, and regional planning and development organizations. The policies which have resulted are nationally known for their emphasis on the revitalization of older urban centers, with a redirecting of state and federal assistance to this end. The state has acknowledged its responsibility to assist this process through targeting state investments to focus on older developed communities, through the infusion of new jobs in these areas, and through growth management and economic development investments which are within control of the state. A great many documents record this process and fully illustrate the emergence of these policies. On the state level, a Development Cabinet, consisting of the Lieutenant Governor, the Secretaries of Manpower Affairs, Communities and Development, Transportation and Construction, Environmental Affairs and Consumer Affairs, and the State Planning Director, who serves as Chairperson, has formulated an economic development program for Massachusetts.

In this program, Artery improvements have been identified as a critical work program element for the state. The Office of State Planning, in conjunction with the state legislature and virtually all of the cities and towns of Massachusetts, has been instrumental in integrating local, regional and state growth policies. These give further emphasis to the important roles of our older urban centers and the need for the state to strengthen and revitalize these places through strategic public investments, along with encouragement of private investments based on the existing and improved public infrastructure. Other state development policies have been profoundly influenced in these directions, and include the state energy conservation program, industrial development strategy, coastal zone management program, and a battery of policies concerned with enhancing the economic strength and environmental quality of the state's developed areas.

Relation to Regional and Local Policies

Within the Boston metropolitan area, regional and local policies have emerged to reinforce the state policies. For transportation, the broad state policies serve as a guide for specific plans and programs which are part of the continuing planning process. Artery improvements were first suggested by the City of Boston some years ago, and the state has been supportive in advancing the concept of improvements within the context of local and regional goals. The state funded preliminary feasibility analyses undertaken by the City. Subsequent regional plans have reflected this joint interest and the proposal for improvement of the Artery has been included in all federally required transportation certification documents produced over the past several years, and has met with approval of the six-agency Metropolitan Planning Organization. Furthermore, the proposed improvement has been integrated with regional plans for open space improvements, water quality management, economic growth and with the current focus on transit and roadway improvements in and around the Core of the region.

Boston's Downtown is important to the present and future of the region - it contains 300,000 of the City's 500,000 jobs and represents 23% of the metropolitan area's 1.3 million jobs and 13% of the state's 2.4 million jobs; it provides $5 billion of the $7.5 billion of earned income for the City, $20 billion for the metropolitan area, and $36 billion for the state.

Programs of the City of Boston are closely integrated on both policy and organizational levels with potential Artery improvement. The City has a long-standing strategy of using public policies and investments to leverage private investment in the Downtown area. Urban renewal programs which began the process of Downtown revitalization are now being completed. Five major renewal projects have been undertaken Downtown, and all are immediately adjacent to the Artery Corridor. New projects which are being developed will fill gaps along the Corridor and strengthen residential and commercial uses. Other new developments are taking place in areas adjacent to Downtown where the Artery serves for principal access. They are located in part on federally-decommissioned lands and are designed in significant part to replace lost jobs. When implemented they will supplement the existing annual Downtown payroll of approximately $3,000,000,000 with an additional input of 23,000 jobs and $250,000,000 annual payroll. As these projects develop, the City anticipates an infusion of over $1 billion in private investment in Downtown and adjacent areas. Improvements to the Artery will strengthen access and other public infrastructure in all of these areas and will assist physical development by including private investments in the core of the region.

Many of the proposed physical changes have been noted in the Corridor Planning Study, and the Artery proposals have been developed in concert with the City. The City of Boston initiated the proposal, and plays a special role through its representation on the Artery Policy Committee and has a uniquely strong role in regional-level policy making through its membership on the Joint Regional Transportation Committee, the Metropolitan Area Planning Council and the MBTA Advisory Board.

Relation to National Policies

Proposals to improve the Central Artery are not only consistent with local, regional and state development policies, but also with federal policies. The Commonwealth's policy for the revitalization of older urban areas has in fact preceded the development of a parallel feature of the Carter Administration's national urban development policy. The present national policy cites Boston as one of its target areas - a city with high unemployment and declining population. Federally-assisted investments in transportation and other areas will be trageted toward revitalizing urban centers so that investments can reinforce one another. In undertaking such an investment policy, the federal goal is to work in partnership with state and regional agencies in furthering locally-defined development goals.

Massachusetts has assisted in the development of policies aimed at reducing urban sprawl and reinforcing the economic vitality of existing urban centers. It has also found means of cooperating

Mr. Norman J. Van Ness August 16, 1978

in the planning and implementation of transportation improvements as an integral element in the strategy to encourage economic growth and development while improving environmental quality. Since these are now federal goals, they are supported by city, regional and state commitments to maintain and upgrade the public infrastructure as a positive inducement to private investment, and to increase potential job opportunities. As stated in the National Urban Policy Report, we intend to "use transportation as an incentive program to leverage public and private urban revitalization activities and make urban transportation programs more effective tools to accomplish improved transportation and broad economic, environmental and social goals." Proposed improvements to the Artery mesh closely with these federal goals. In addition, in every instance where federal guidelines or policy directions have been applicable, we have guided or modified our proposals to assure that they are consistent. These include, but not limited to, such varied guidelines and controls as the Environmental Protection Agency Air Quality control provisions, the Coastal Zone Management Porgram, and the Uniform Relocation Assistance and Real Property Acquisition Policies Act.

Conclusion

The proposed improvement of the Central Artery has been advanced within an overall process which has involved all levels of government in Massachusetts. Initiation of the project by the City of Boston has been followed by procedural steps on all levels to assure that the proposal will be thoroughly examined before a final decision is reached. This examination will of necessity be a complex and lengthy process, involving not only the individuals and agencies already included, but many more by the time a decision is made. I am convinced that the process of detailing the implications of Artery alternatives is essential, and that the present documents are substantial evidence of problems which must be dealt with by proceeding to full-scale environmental impact analyses for both the Central and South areas.

Very truly yours,

JOHN J. CARROLL
COMMISSIONER

CENTRAL ARTERY / I-93 CORRIDOR

SOUTH AREA PLANNING STUDY

Prepared for the Massachusetts Department of Public Works
by the Central Transportation Planning Staff
in conjunction with the MDPW Central Artery Project Staff

March 1978

This report has been prepared pursuant to the requirements of the Massachusetts Action Plan, with the financial assistance of the Federal Highway Administration and the Massachusetts Department of Public Works.

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CHAPTER I. SUMMARY OF FINDINGS

I.A Purpose

This report is a preliminary overview of engineering and environmental impact studies completed for the South Area of Boston's proposed Central Artery project and is the basis for detailed future engineering, environmental and related studies.

In the report, the South Area is described in terms of existing facilities, system characteristcs, traffic characteristics, and environmental conditions. Then, alternatives for improvement are presented both in terms of possible construction external to the Central Artery Corridor and in terms of potential actions solely within the South of the Artery Corridor. Subsequently, alternatives outside of the Central Artery Corridor are eliminated from further consideration because of construction, traffic, and/or environmental problems. Attention is then devoted to construction alternatives solely within the South Area of the Central Artery Corridor.[1]

Nine construction options are described and evaluated, and seven are proposed for further study. Finally, general conclusions and recommendations are reached regarding potential construction in the South Area. Throughout this report, results are utilized from various analyses performed by the Massachusetts Department of Public Works (D.P.W.) and other organizations.

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1 Construction options for the South and North Sections of the Central Artery Corridor are taken up in separate reports.

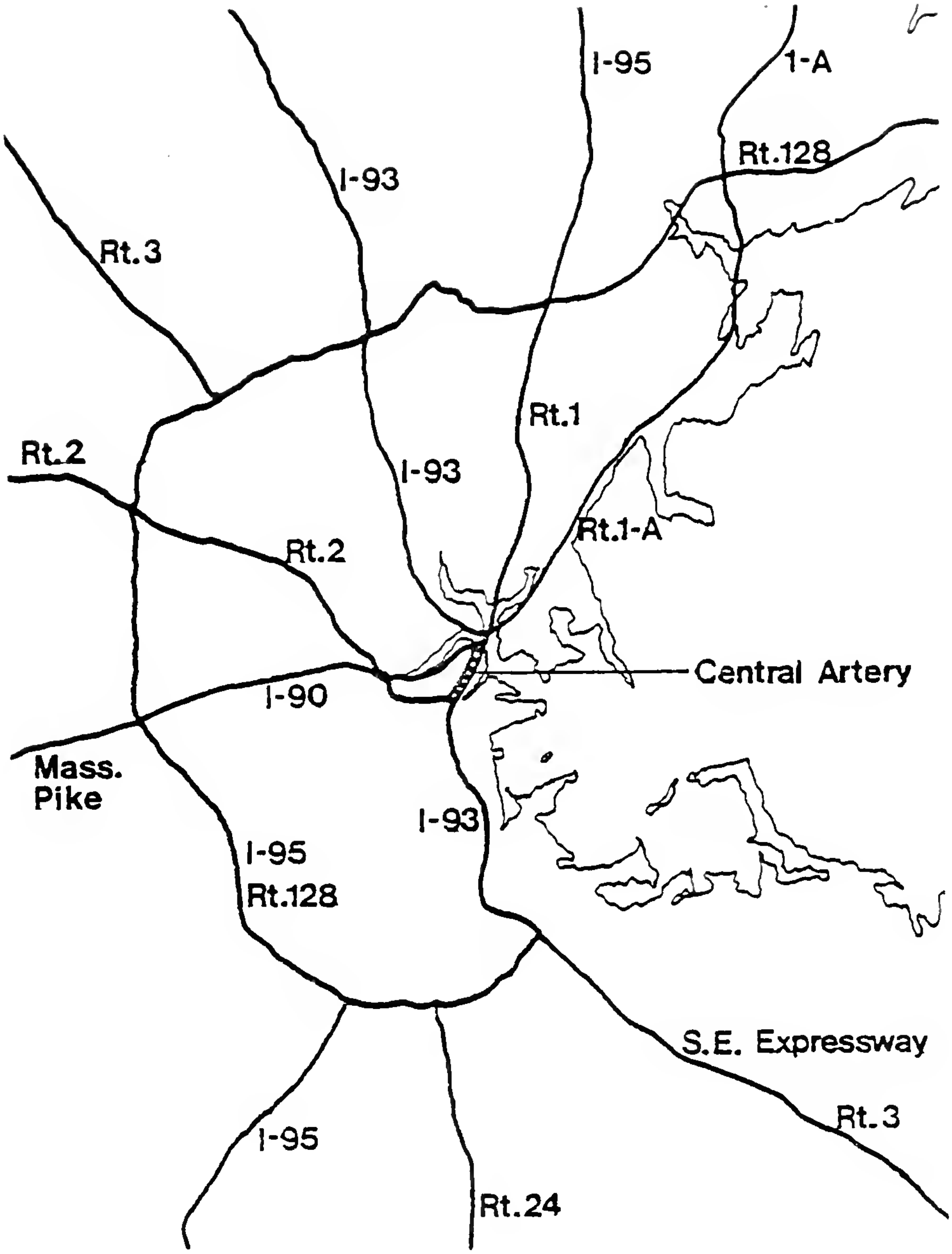
THE CENTRAL ARTERY

The Central Artery (I-93) is a multilane freeway traversing the Boston core area. It stretches in a generally southerly direction from the junction of I-93 and the Mystic River Bridge approach in Charlestown north of downtown Boston, over the Charles River, through downtown Boston, and then south to the interchange between Massachusetts Avenue and the Southeast Expressway just south of Boston's central business district. It is about three miles long. Figure 1 shows the Central Artery in the context of the regional Boston express highway system.

The Central Artery connects with a number of arterial highways along its length. As seen in Figure 2, just south of the Charles River it connects with the McGrath/O'Brien Highway and Storrow Drive which provide service to the northwest and west respectively. In the downtown area itself, the Central Artery connects with the Callahan and Sumner tunnels which provide service to and from East Boston and Logan Airport. In downtown Boston, the Central Artery has connections with many downtown streets. South of downtown, it has a large interchange with the eastern terminus of the Massachusetts Turnpike.

Through its various interconnections, the Central Artery provides access to a number of distinct districts of the Boston central area. Included in the areas served are the financial district, the retail shopping area, the office district, the Government Center, the industrial and seaport areas in South Boston and Charlestown, the industrial areas of East Cambridge and Charlestown, the North End, the North Station area, the Waterfront, Chinatown, the South End, West End, South Cove and South Boston residential areas.

When the Central Artery was constructed in the 1950's, it was conceived as the most important link of the full expressway network proposed in the 1948 master highway plan for the Boston area.



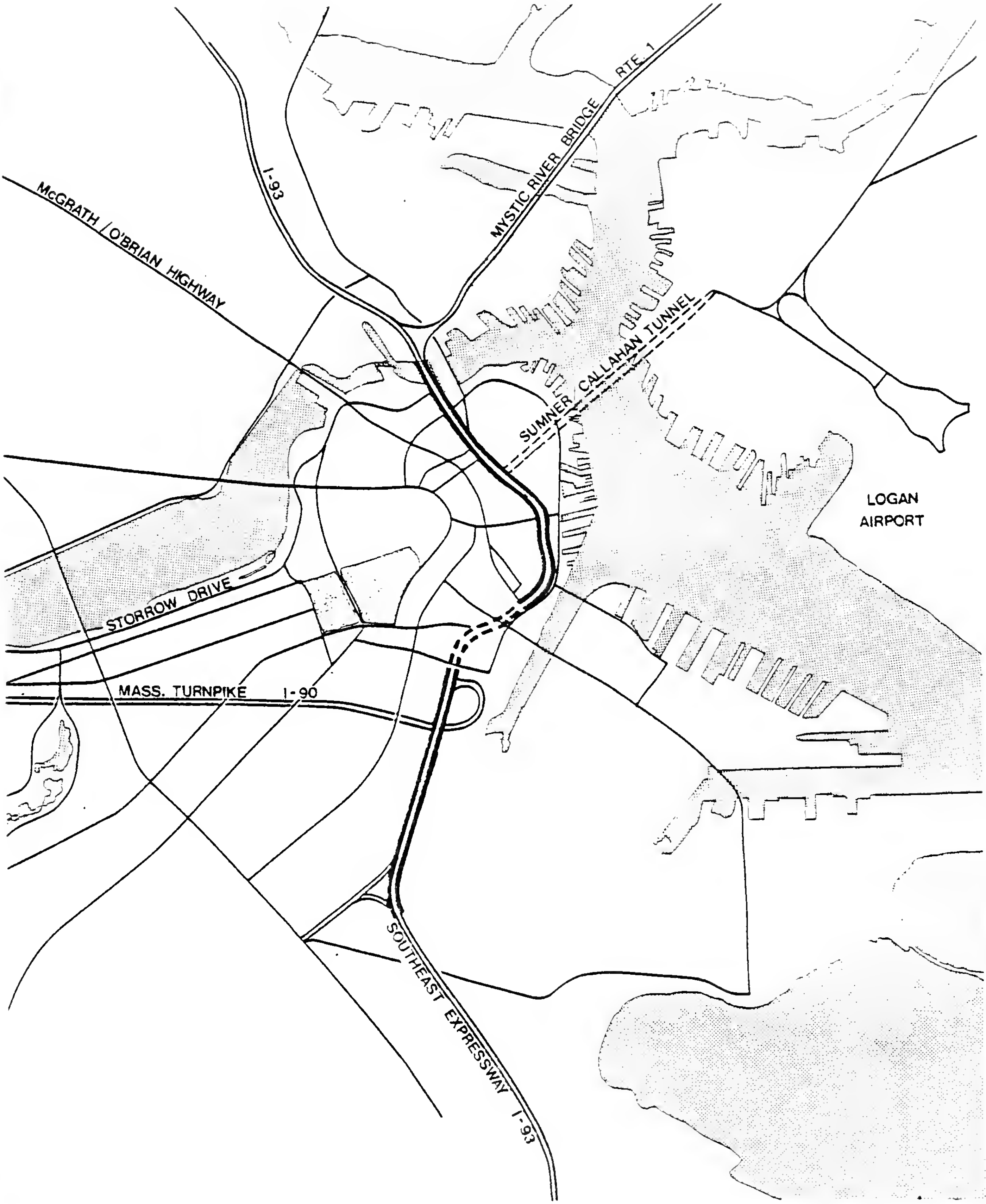
REGIONAL NETWORK

Figure 1

Because the Central Artery was built before the Interstate highway program, it was built without Federal assistance, and its capacity and design were restricted. As a result of insufficient capacity - generally the Central Artery is a six lane facility - it acts as a bottleneck both to the north and to the south. At its northern terminus, five lanes from I-93 merge with five lanes from the Mystic River Bridge to form a facility of only six lanes across the Charles River. At the south end of the Central Artery, six lanes from the Southeast Expressway and six lanes from the Massachusetts Turnpike also merge together in a facility only having six lanes. Traffic going from and to other major roads along the Central Artery compounds the problems caused by the Artery's insufficient capacity.

From a design point of view, the Central Artery is also inadequate by modern standards. In its three mile length, it has no breakdown lanes. It also has a total of 42 ramps, 25 for local service, and 17 for connections to expressways, the Mystic River Bridge, and the tunnels. Because of the lack of breakdown lanes, any traffic incident in either roadway, even a stalled vehicle, diminishes effective capacity in the direction affected by at least one third. Because of the original design, the ramps are also inadequate, having insufficient speed change lanes and sight-lines. This results in severe safety hazards and further diminishes the effective capacity of the Central Artery roadway. In addition, the closely spaced ramps cause conflicts with through traffic. Some ramps use surface streets for through expressway traffic which conflicts with surface traffic and pedestrians. Finally, much of the Central Artery is an unsightly elevated structure which is generally regarded as a blighting influence on downtown Boston with severe aesthetic and other negative environmental impacts.

In addition to these problems, it is apparent that the decks of the Artery must be replaced by 1984-1989. These concerns have led to several Central Artery studies, including the current ones, all developed to determine how best to address the deficiencies of the facility.



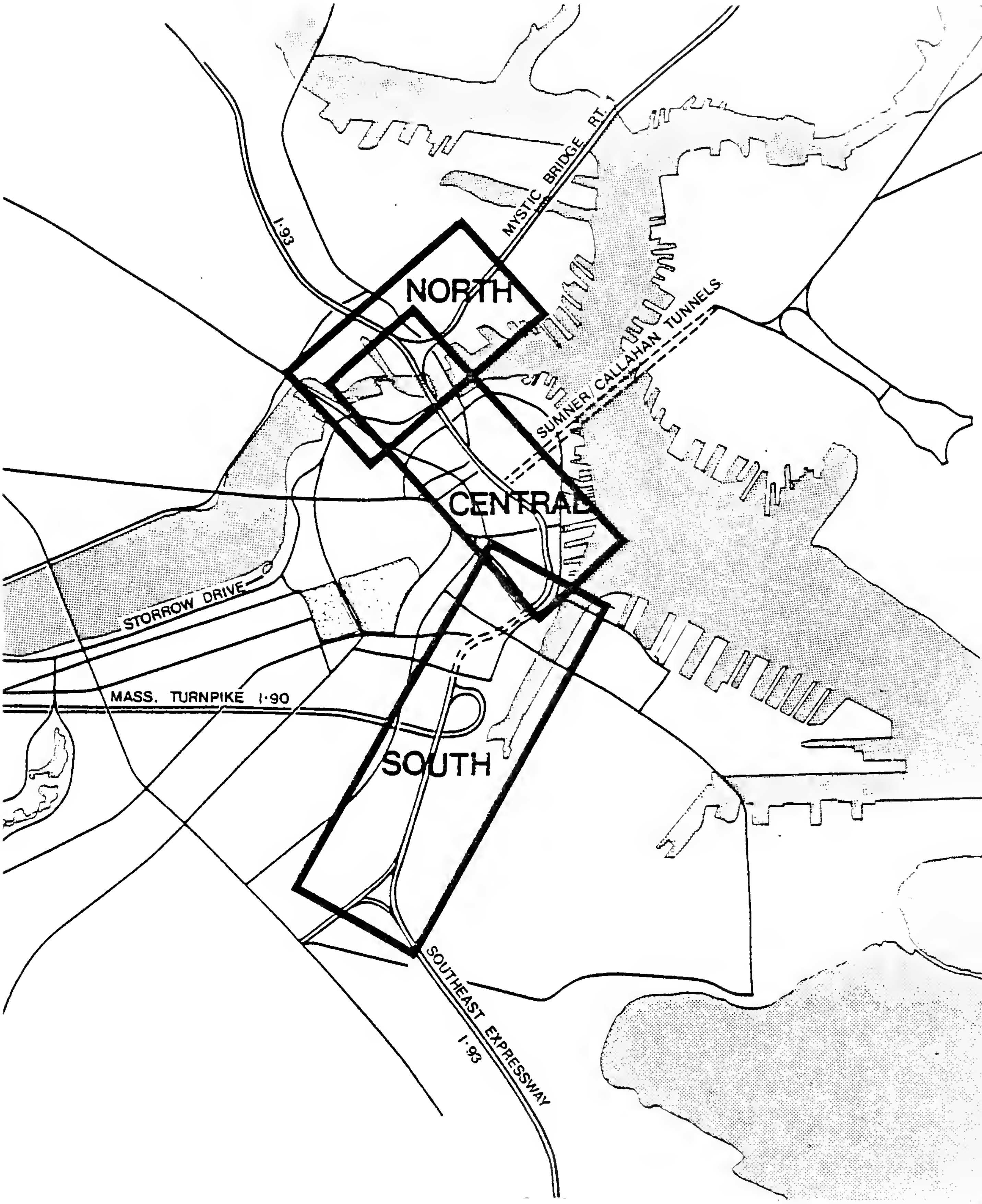
CENTRAL ARTERY

Figure 2

THE CENTRAL ARTERY CORRIDOR

For purposes of planning, the Central Artery Corridor has been defined as the area stretching roughly half a mile on either side of the Central Artery roadway, and a similar distance beyond each end of the Artery. As such, the corridor encompasses the entire area that is likely to be physically affected by potential Central Artery reconstruction. The area of the corridor includes about half of Charlestown, most of downtown Boston, and portions of the South End and the industrial area of South Boston.

Figure 3 shows the three designated subareas of the Central Artery Corridor: North, Central, and South. These areas have been defined to help plan and advance Central Artery improvements in sub-sections that are both analytically manageable and financially feasible. From an analysis point of view, this definition of subareas is helpful because it allows greater focus on alternatives and their impacts. From a financial point of view, this provides a basis for realistic assessment of the probable sequencing of funding and construction timing for potential project elements. It also allows potential improvements to be made on varying time schedules and expenditure levels. Geographically, the Artery also divides naturally into North, Central, and South sections with largely separable functions and physical features. Thus potential improvements to the different sections, while fitting together in a unified structure, nonetheless have individual benefits and can be constructed independent of one another.



ARTERY CORRIDOR STUDY AREAS

Figure 3

ALTERNATIVES TO CONSTRUCTION IN THE CENTRAL ARTERY CORRIDOR

Several alternatives to construction in the Central Artery Corridor have been explored in various studies. These have been extensively reexamined and found to be inadequate to solve the various operational and safety problems of the Artery. These alternatives are described below and illustrated in Figure 4. All have been dropped from further consideration.

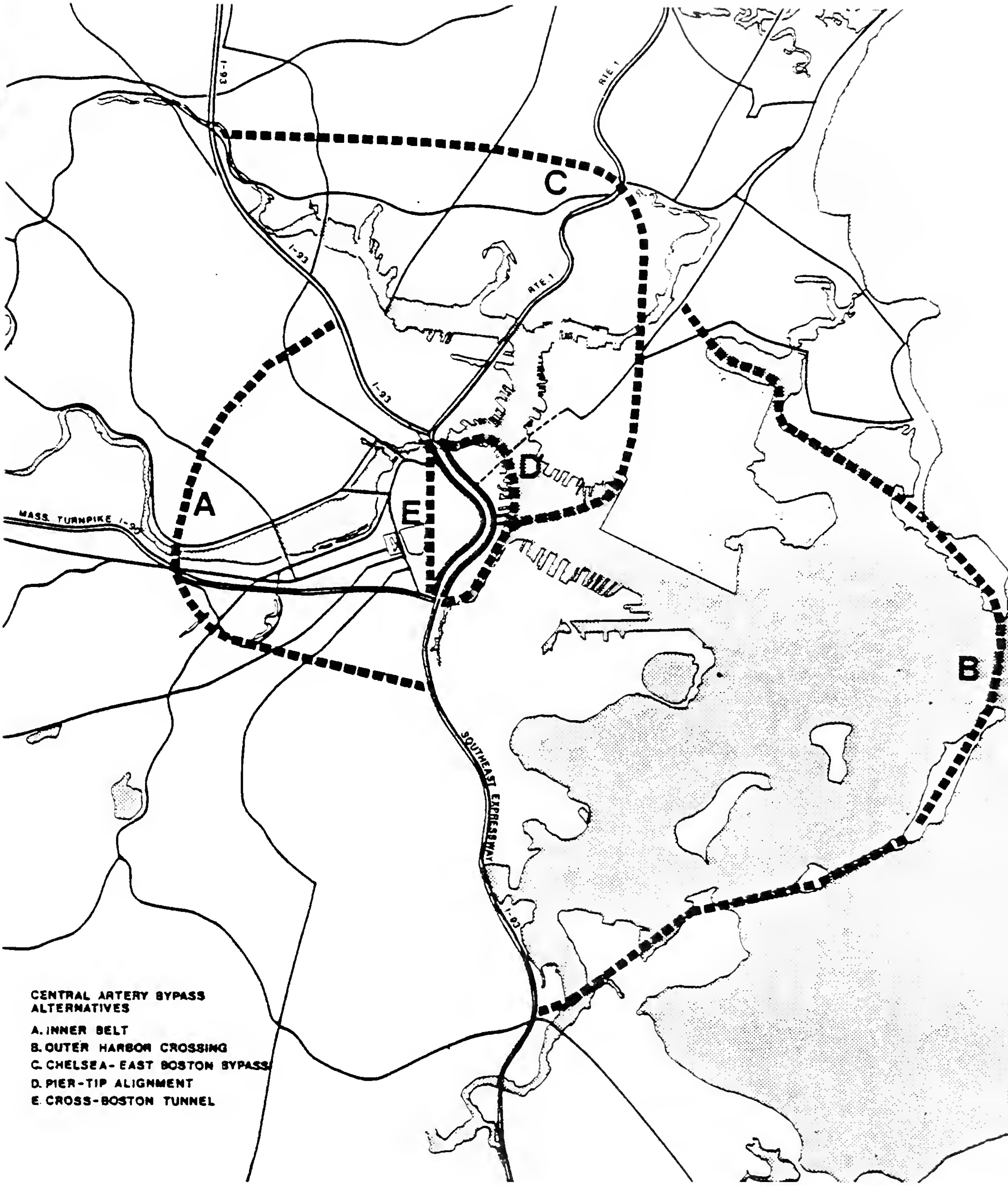
ALIGNMENTS OUTSIDE THE CORRIDOR

1. The Inner Belt. This option was ruled out by governor Sargent in 1971 for these reasons: residential takings and relocation requirements, community disruption, community protest, technical questions regarding ability to accommodate projected traffic volumes, and generation of additional traffic for the Boston core area.

2. Outer Harbor Crossings. This proposal for a highway from Quincy to Winthop via the harbor islands and a combination of bridges and causeways was ruled out because of environmental impacts, intrusion into the flight paths of Logan Airport, inadequate provisions for connections to other expressways, and lack of downtown collection and distribution relief.

3. Chelsea/East Boston Bypass - This option from I-93 North via Chelsea and East Boston to a tunnel under the harbor was ruled out, among other reasons, because of residential takings and relocation requirements, community disruption, impacts on shipping in Chelsea Creek, the necessity of a tunnel under East Boston, and partial dependence on I-95 in Lynn (dropped in 1972) and the proposed I-95 Relocated in Revere (dropped in 1972). The tunnel under the harbor is the proposed Third Harbor Crossing, a part of the projected ultimate regional expressway network. It is considered in this report as it relates to South Area studies.

4. Pier Tip Bypass - This alternative would consist of a highway from Charlestown to South Boston via a harbor tunnel



ALTERNATIVES TO THE ARTERY CORRIDOR

Figure 4

along the tips of the downtown piers. It has been eliminated from further consideration because of the lack of necessary connections with the Sumner-Callahan tunnels, steep grades, and difficult design and engineering problems including ventilation and interconnections with other expressways.

5. Cross Boston Tunnel - This option includes a tunnel from Charlestown to South Station under Beacon Hill, the Boston Common, and the downtown Boston retail area. It was ruled out because of technical infeasibility, questions of grades and ventilation, lack of interconnections with expressways, failure to connect with the Sumner-Callahan tunnels, and lack of collection/distribution services.

2 Analysis of Alignments Outside the Corridor

Analysis of solutions to the Central Artery problems by construction outside the corridor yields several major conclusions. First, technically and socially acceptable alternative alignments to provide for Central Artery functions cannot be found outside of the corridor. Second, the present corridor is the only one that can effectively connect with all of the expressways and tunnels, and also serve downtown collection/distribution needs.

For these reasons, and because extensive deck repairs must be made in the elevated portions of the present Central Artery regardless of whether other improvements are undertaken, it is appropriate that specific alternative improvement projects be developed for the Central Artery corridor. In accordance with normal highway planning practice, the alternatives include the "no-build" option, which would, as a minimum, provide for necessary bridge deck replacement.

I.E THE CENTRAL ARTERY SOUTH PORTION: DESCRIPTION, SERVICE PROBLEMS, AND ENVIRONMENTAL IMPACTS

I.E.1 Description

The south portion of the Central Artery lies on the south side of the downtown Boston area, and includes the Dewey Square (or South Station) Tunnel and the elevated portion of the roadway leading from the tunnel into the Southeast Expressway. The major intersection in the south segment of the Central Artery is the complex interchange with the terminus of the Massachusetts Turnpike (Interstate Route I-90). In addition, there are many other access ramps to local streets and arterials throughout the length of this portion of the Artery. South of the Turnpike interchange, frontage roads provide access to and from the Artery as well as service to industrial areas. Areas over the Dewey Square Tunnel include a surface arterial, which becomes parallel one-way streets north of Dewey Square.

I.E.2 Transportation Service Problems

The south portion of the Central Artery has a number of service problems resulting from inadequate capacity and restricted design. The major capacity problem is caused by the merging of the Massachusetts Turnpike and the Southeast Expressway into the Artery. This capacity problem is seen most strikingly in the Dewey Square Tunnel, in its approaches to the south, and on the surrounding neighborhood streets. The tunnel itself was designed for an average daily traffic load of 77,000 vehicles. It is presently carrying approximately 135,000 vehicles daily. With this situation, traffic is severely congested in the tunnel, operating under forced flow conditions during peak periods, and often during off-peak periods as well. The capacity problem is also seen in the form of substantial queuing in the northbound lanes south of the Dewey Square Tunnel, mostly during the morning peak. Morning queues are average about a mile and one-half in length, and their length and duration have grown over the years. Finally, the capacity problem of the Dewey Square Tunnel is exacerbated by inbound morning traffic which uses local streets to avoid the congestion of the tunnel. This situation is reversed in the evening.

The problem of insufficient lanes in the South Area portion of the Central Artery is compounded by the design of the facility, particularly in the Dewey Square Tunnel. In the tunnel there are substandard sight-lines and excessive curves and grades. Throughout the South Section of the Artery there is a lack of adequate acceleration, deceleration, and breakdown lanes. Ramps are numerous and poorly placed, allowing insufficient distances for merging and weaving. All of these problems have acted to diminish capacity further, and have contributed to an accident experience that is far above average. During 1975, the South Section of the Central Artery experienced 449 reported accidents. On a vehicle mile basis, this is about three times the national average for urban expressways.

Finally, the decks of the elevated portion of the Central Artery South Section are experiencing rapid deterioration and will require major repairs and/or replacement in the near future. Emergency maintenance contracts have already been let in attempts to reduce the rate of deck deterioration.

.3 Environmental Impacts

The South Section of the Central Artery is associated with several negative impacts on the surrounding areas. South of the Dewey Square Tunnel, the facility produces air pollution, dirt, and a considerable amount of noise. The impact is particularly felt in Chinatown adjacent to the interchange between the Artery and the Massachusetts Turnpike.

In the Dewey Square Tunnel area, the Artery itself does not cause excessive problems of air pollution and noise, as it is an enclosed structure with ventilation stacks. Noise problems are caused by the diverted traffic using local streets above the Artery.

Local access between surface streets and the Artery is inadequate to serve downtown financial and commercial area needs. Access locations are poorly designed in relation to emerging land use patterns and proposed new developments.

Finally, there is concern that extensive takings and environmental damage occurred to the surrounding area when the Dewey Square Tunnel was constructed. There is a strong desire that in any new construction, damage in the area be ameliorated rather than made more extensive.

I.F Alternatives within the Central Artery Corridor

Analysis of the South Area of the Central Artery corridor has led to two main groups of alternatives for consideration. The first group would result in artery traffic in both directions continuing to follow the present alignment. This includes the no-build alternative and alternatives for widening or double decking the present facility. The second group would result in a split alignment along part of the corridor, with southbound flow on the present alignment and northbound flow on one of two potential new alternative alignments.

I.F.1 Improvements Along the Present Alignment

This set of improvement alternatives centers on the existing Dewey Square Tunnel.

a. No Build - In this alternative the existing facility is retained and modified as necessary to accommodate minor improvements for traffic service and safety. Traffic capacity and design standards would remain the same as they are today. Deck rebuilding would be required south of the Dewey Square Tunnel because the decks are approaching the end of their useful life.

b. Widening of the Dewey Square Tunnel - There are several possibilities for widening the Dewey Square Tunnel. These range from the addition of modest improvements to the breakdown and speed change lanes to the addition of new lanes for carrying traffic. If new lanes are added, they must be located outside the existing tunnel on one or both sides with traffic reallocated between existing and new facilities. Preliminary analysis indicates that impacts from widening the present facility are extremely damaging to adjacent communities and would be unacceptable to community leaders. South of the Dewey Square Tunnel the viaduct would consist of three lanes in each direction with a shoulder used in peak hours to accommodate traffic demand.

c. Double Decking the Present Facility - This alternative would create an additional level of highway in a viaduct over the surface street which is now above the Dewey Square Tunnel. Capacity in the South Area would be increased, and the tunnel would no longer act as a bottleneck for traffic, because the Dewey Square Tunnel would only carry southbound traffic and the new facility only northbound traffic. This alternative would also be unacceptable to communities nearby and would extend this blighting effect of the elevated structure into the Dewey Square area.

2 Split Alignment Alternatives

This set of improvement alternatives centers on use of both an improved Dewey Square for southbound traffic and a new facility parallel to the tunnel for northbound traffic. This new facility could be located in one of two locations either the Fort Point Channel or Atlantic Avenue.

a. Fort Point Channel Split Alignment - This alternative would have a new northbound tunnel in the Fort Point Channel-parallel to the existing Dewey Square Tunnel, which would serve southbound traffic. The new tunnel would begin at the Turnpike interchange and extend in the Channel to join the existing Central Artery right-of-way in the vicinity of the Northern Avenue Bridge. In this alternative, the Dewey Square Tunnel would no longer be a constraint on traffic. Design constraints would be greatly diminished because geometrics of both the Dewey Square Tunnel and the new pathway would be modified to meet acceptable design standards. This right-of-way affords ease of construction because of the relatively clear alignment, without physical restraints imposed by existing development.

b. <u>Atlantic Avenue Split Alignment</u> - This alternative is similar to the Fort Point Channel Split alignment, except that the new north-bound right-of-way would be under Atlantic Avenue. The new tunnel would extend from the existing right-of-way under the rail yards and Atlantic Avenue and rejoin the present Artery near Dewey Square. This alternative is more difficult to construct because it must pass under commuter rail and AMTRAK lines, be constructed under an existing heavily travelled street, above an existing rapid transit station at South Station, and because of a narrow right-of-way at Dewey Square.

The latter constraints would make it extremely difficult, if not impossible to add a transit connection between North and South Stations as part of the Central Area reconstruction project, should it be undertaken.

I.F.3 <u>Analysis of Alternatives</u>

Preliminary investigation of the alternatives for the South Area has indicated that the alternative of double decking the present Dewey Square Tunnel should be dropped immediately because of severe environmental and economic impacts on adjacent properties, particularly in the congested areas around the Dewey Square Tunnel. Additionally the difficult design and engineering problems of connecting the upper roadway to other expressway and local streets requires additional land takings and would therefore provide additional negative impacts on adjacent properties.

Because the present Dewey Square Tunnel is built as an integral structure a major widening would require the construction of one or more parallel tunnel roadways on one or more sides of the present alignment. Impacts of maintaining traffic during construction and demolishing buildings along the right-of-way would be severe.

Because of these problems, a major widening of the Dewey Square Tunnel should also be dropped, though additional analysis will be done to evaluate and document more fully the extent of these adverse effects prior to undertaking intensive analysis of environmental impacts of the remaining alternatives.

There may be some alternatives involving widening of lesser proportions which may be useful in developing a no-build alternative that offers transportation service improvements beyond simply maintaining the existing situation. These will be evaluated as variants of the No-Build Alternative.
Both of the Split Alignment Alternatives have been retained for further study. However, both alternatives (Fort Point Channel and Atlantic Avenue) afford similar transportation service improvements for the South Area. In both alternatives a new right-of-way for northbound traffic is proposed to overcome the right-of-way constraints present in alternatives which are restricted to the Dewey Square Tunnel. The Atlantic Avenue Alternative is a variation on the split alignment in the Fort Point Channel and is rather recent in origin and has resulted from review of widening alternatives. Therefore it has been retained to allow further detailing. For purpose of this discussion, the Atlantic Avenue alignment is included as a variation of the Fort Point Channel Split Alignment.

There are two basic types of alternatives- the No Build and the Split Alignment-with variations to each, as discussed above. The two basic alternatives must be examined in relation to other potential transportation improvements which affect the South Area. These are the proposed improvements in the Central Area of the Artery corridor and the proposed third harbor tunnel between downtown and Logan Airport. Proposals for a third harbor tunnel include two options - a special purpose tunnel limited to buses, taxis, limousines and emergency vehicles, and a general purpose tunnel open to all traffic. In either case, the third harbor tunnel would serve only Logan Airport.

These potential projects outside of the South Area would impact South Area alternatives in several ways. Potential improvements in the Central Area of the Artery corridor would influence at least the design of the connection between the South and Central Areas and the travel time benefits of both areas. Similarly, the third harbor tunnel would affect the design of the South Area alternatives if it shared an alignment in the Fort

Point Channel. The design implications differ depending on whether the tunnel is for special or general purposes.

In sum, the two basic options for the South Area - No Build and Split Alignment - must be analyzed with all the combinations and permutations of the other projects: with and without the Central Area improvements, and with and without a third harbor crossing either special or general purpose. Altogether this comes to a total of nine alternatives as shown in Figure 5. The nine initial alternatives for analysis are described below.

Figure 5 : South Area Alternatives

		With 3rd Harbor Crossing	
	Without 3rd H.C.	Special Purpose	General Purpose
NO BUILD	Alt. 1	Alt. 2	Alt. 3
SPLIT ALIGNMENT WITHOUT CENTRAL AREA	Alt. 4	Alt. 5	Alt. 6
SPLIT ALIGNMENT WITH CENTRAL AREA	Alt. 7	Alt. 8	Alt. 9

Alternative 1: The No Build Alternative

The No Build Alternative has been developed to explore the possibility of retaining the existing facility with some modifications to prolong its useful life. South of the Dewey Square Tunnel, the Artery decks need replacement in the near future if no other improvements are made. In undertaking this work, one lane of decking would be done at a time. Traffic would be maintained, but during construction capacity on the roadway would be reduced by approximately one-third. Some frontage road capacity could be used during construction.

In the Dewey Square Tunnel area, modification could range from minor changes to the tunnel to selecting widening to improve traffic operations. Alternative 1 can be constructed with or without the proposed Central Area project in the Artery corridor.

Alternative 2 - The No Build Alternative with a Special Purpose Third Harbor Tunnel

Alternative 2 is similar to Alternative 1 in all respects, except for a special purpose third harbor tunnel. The connection between the South Area expressway facilities and the proposed tunnel would be made at the interchange between the Southeast Expressway and the Turnpike. The two-way special purpose tunnel would be located in the Fort Point Channel. The tunnel would be built as a separate project, independent of improvements for the South Area of the Artery.

While the special purpose tunnel would provide improved service to limited types of vehicles, it would primarily serve only those vehicles approaching it from the west and south. From other directions such vehicles would have to travel the full length of the Artery to reach the tunnel approaches. It would have the salutary effect of removing vehicles from the Central Area of the corridor, to the extent that the service provided by buses or other multiple occupancy vehicles could attract more ridership.

Alternative 3 - The No Build Alternative with a General Purpose Third Harbor Tunnel

This alternative is identical to Alternative 2 with the added feature of diverting general traffic from the existing Artery to the third harbor crossing. As in Alternative 2, the proposed harbor tunnel would be built in the Fort Point Channel with its interchange at the junction of the Southeast Expressway and the Massachusetts Turnpike.

Alternative 4 - Split Alignment without the Central Area Project

In this alternative, the South Area of the Artery is reconstructed but no major improvements are made to the Central section. The reconstruction of the South Area would include a new northbound tunnel of three lanes, with shoulders used in peak hours to accomodate traffic demand. It would be located under Atlantic Avenue or in the Fort Point Channel and would be connected to the elevated Central section in the vicinity of Northern Avenue. The Dewey Square Tunnel would be retained for southbound movement, but could be modified for better geometrics and lane configuration. It would include three southbound lanes, with shoulders used in peak hours to accomodate traffic demand. Local street connections would be modified to provide improved service between the expressways and the surface street network in the South Boston seaport areas, South Station and the proposed transportation terminal, and the retail and financial districts of Downtown Boston.

Alternative 5 - Split Alignment without the Central Area Project and with a Special Purpose Third Harbor Tunnel

This alternative is similar to Alternative 4, with the addition of the special purpose tunnel to and from the airport. Connection to and from the harbor tunnel would be made via the relocated northbound roadway of the split alignment.

This alternative would allow construction of the northbound roadway and the special purpose tunnel to be undertaken without disruption to existing Artery traffic.

Alternative 6 - Split Alignment without the Central Area Project and with a General Purpose Third Harbor Tunnel

This alternative is identical to Alternative 5 with the exception of general purpose traffic utilizing the proposed harbor tunnel.

Alternative 7 - Split Alignment with the Central Area Project

Alternative 7 provides for a major improvement in the South Area with the construction of a new northbound roadway either under Atlantic Avenue or in the Fort Point Channel. The existing Dewey Square Tunnel would then become one-way south bound. Both the relocated northbound roadway and the improved southbound roadway would be linked to a reconstructed Central Area. This connection, located near the Northern Avenue Bridge, would be underground. Revisions to the existing ramps in the Dewey Square Tunnel would be necessary to provide appropriate connections with local streets. New connections to local streets would be provided from the new northbound tunnel to local streets including Northern Avenue, Kneeland Street/Atlantic Avenue, Broadway as well as access to and from the proposed transportation terminal at South Station. Additional connections could be provided at a later date to the proposed third harbor tunnel if that facility is to be constructed.

In this alternative, construction of the northbound roadway would be undertaken without serious disruption to existing Artery traffic. After completion of the tunnel, connections to roadways on either end of the Dewey Square Tunnel could be reconstructed without excessive traffic disruption. As northbound traffic would be in the new alignment, southbound traffic can be detoured between the existing north and south bound lanes of the Dewey Square Tunnel during construction.

The proposed North Station-South Station rail connection, which is part of the Central Area project, is not a part of any alternative for the South Area, except immediately behind South Station.

Alternative 8 - Split Alignment with the Central Area Project and a Special Purpose Third Harbor Tunnel

Alternative 8 is similar to Alternative 7 and includes a special purpose third harbor tunnel to and from the airport. The tunnel would connect with the South Area project at the mouth of the Fort Point Channel, and would link to the new northbound roadway and the existing Dewey Square Tunnel. Local street connections would be provided as in Alternative 7.

As in Alternative 7, construction of the northbound roadway and the special purpose tunnel would be undertaken without serious disruption to traffic on the I-93 northbound roadway. Construction phasing of this alternative would be closely related with the Central Area phasing.

Alternative 9 - Split Alignment with the Central Area Project and a General Purpose Third Harbor Tunnel

Alternative 9 is identical to Alternative 8 except that the third harbor tunnel is a general purpose facility to and from the airport. The tunnel would connect with the South project at the mouth of the Fort Point Channel and lead to the airport access road. Direct connections to and from the North Shore would not be provided in this option. However, there would be direct connections for traffic from the Southeast Expressway and the Massachusetts Turnpike into the harbor tunnel. Access from the north and northwest to the new tunnel would be less direct; this traffic would continue to use the present harbor tunnels for access to and from the airport.

I.G CONCLUSIONS AND RECOMMENDATIONS

Severe capacity and safety problems and design deficiencies exist in the South Area portion of the Central Artery. In the near future it will at a minimum be necessary that deck repairs be made to the existing facility in order to keep it operating. At this point, however, it is appropriate that alternative actions be analyzed that address both the maintenance of its functional integrity, and also potential means to resolve its basic capacity, design, and environmental deficiencies.

Initial analysis has shown that there are no feasible construction alternatives outside of the Central Artery corridor that can resolve traffic problems within the corridor. Also, transit options cannot solve the corridor highway problem. In the South Area, there are two basic alternatives to be considered: No Build and Split Alignment. Each of these has been analyzed in combination with potential Central Area improvements and alternatives for a Third Harbor Tunnel. A total of 9 alternatives was studied, three of which directly address problems of the South Area. These are alternatives 1, 4 and 7, and they should be carried into further environmental and engineering analysis. In subsequent studies of these alternatives, they will be designed to accomodate the potential Third Harbor Tunnel as a separately built, but physically connected future project. Alternatives 2 and 3, which include an independent Third Harbor Tunnel, preclude South Area improvements on a split alignment and do not make improvements to the Artery beyond those in Alternative 1. For these reasons, Alternatives 2 and 3 should be dropped from further consideration as potential solutions for the South Area of the Artery. Alternatives 4 and 7 advance the Third Harbor Tunnel because they could later be connected to it. Alternatives 5,6,8 and 9 are permutations of Alternatives 4 and 7 which include a Third Harbor Tunnel, but they are otherwise identical to Alternatives 4 and 7. Of these six alternatives, 4 and 7 should be carried forward into further engineering and environmental analysis.

It should be noted that the construction of a Third Harbor Tunnel is a separate project, serving purposes and having benefits which are different from the reconstruction of the South Area of the Artery Corridor. The alternatives which have been developed for the South Area, and which should be carried forward (Alternatives 1 ,4, and 7) have inherent flexibility to accomodate a potential Third Harbor Tunnel while meeting South Area needs.

Major reconstruction of the South Area of the Artery offers the possibility of implementing a long-range strategy for the improvements of the economic future of Downtown Boston.

The Artery affects the economic vitality of all of Downtown Boston, which is not only the core of the metropolitan area, but the economic and cultural focus of the New England region. The proposed improvement alternatives affect both the local community and the metropolitan and New England regions in different ways.

As South Area planning proceeds, and in accord with contemporary transportation planning practices, detailed studies are appropriate for all the presently retained South Area alternatives. In particular, the following tasks require special attention:

<u>Transportation Service</u>

- Central Artery service
- Harbor crossing demand and airport service
- Local street service
- Capacity/demand

<u>Design</u>

- Overall design concept
- Structure requirements
- Decking requirements
- Tunnelling requirements
- Ventilation requirements
- Dangerous cargo handling
- Joint rail line construction
- Existing rail line service requirements.
- Joint development opportunities
- Land use and urban design

<u>Impacts</u>

- Economic impacts (regional and local) during and after construction
- Social impacts (regional and local) during and after construction
- Air, noise, and water quality impacts

<u>Construction Techniques and Phasing</u>
<u>Safety During and After Construction</u>
<u>Costs</u>

Other tasks for specific consideration will become clear as the design studies themselves are planned in detail and subsequently undertaken.

CHAPTER II: THE SOUTH AREA

II.A DESCRIPTION OF THE EXISTING FACILITIES

The South Area is the key highway segment linking the Southeast Expressway (the only major highway from the South Shore Corridor) and Massachusetts Turnpike from the Western Corridor to downtown Boston and Logan Airport. Conflicts and congestion caused by the mix of local downtown traffic, Logan Airport traffic and intra-metropolitan through traffic reduce the level of service. In addition, the number of on-and-off ramps for local access in the relatively short distance provides poor highway geometrics with extremely short merging and weaving distances, causing traffic bottlenecks and unusually high incidence of accidents. Reduced sight distances within the Dewey Square Tunnel increase hazards on this section.

The South Area includes major gateways to Boston from the south and west. All vehicular and transit access from the south passes through the area; vehicular access from the west via the Massachusetts Turnpike also enters Downtown through this area. The geographic constraints on the area were formed by the rivers and harbor which still define the setting and affect land development and transportation.

Transportation linkages were established early in the corridor to the south. When first constructed in the early 19th century, they were built over bodies of water in order to connect to the downtown Boston peninsula. Bridges and roads built in the early 18th century provided the first links to the south corridor and gradually became major highways. Until construction of the Southeast Expressway (now I-93), major highways connecting the Boston Downtown to the South Corridor were Washington Street, Blue Hill Avenue, Dorchester Avenue, Summer Street and Broadway.

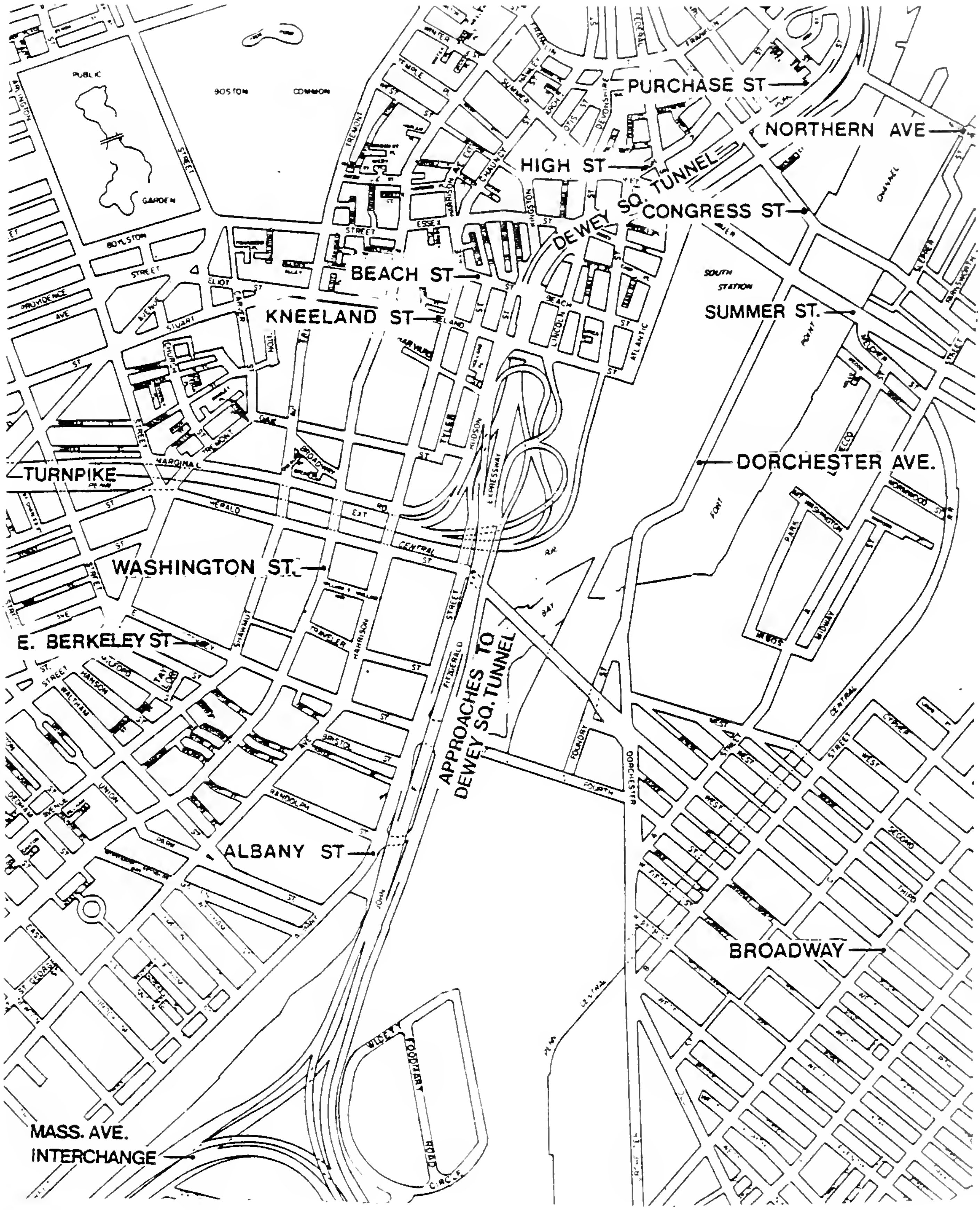
Rail lines to the south corridor originally served individual termini, but were consolidated into South Station in 1898. Certain of the lines to the west were also consolidated into South Station at that time. Upon completion of the Southeast Expressway the rail lines to the south corridor were abandoned for passenger service. Although the Red Line rapid transit serves the inner portions of the corridor, rail transit access to the south corridor was not provided until the opening of the Quincy Extension in 1973.

The major highway to the south - the Southeast Expressway - was built as an extension of the elevated portion of the Central Artery and opened in 1959. The Dewey Square Tunnel was a major portion of the construction necessary to link the Central Artery with the Expressway. Some years later, in 1965, the Massachusetts Turnpike from the west was added, with a terminus at the Central Artery in the vicinity of South Station. At the present time these two roadways form the major feeders into Downtown in the South Area. Both routes provide local service into neighborhoods along the fringe of Downtown.

II.B. SOUTH AREA SYSTEM CHARACTERISTICS

II.B.1. The Dewey Square Tunnel

From a traffic operations point-of-view, the South Area has a major inherent defect: all downtown-oriented traffic to and from the South must use the Dewey Square tunnel, its approaches from the South, or both. For traffic to and from the south, avoiding these two facilities is almost impossible. The only options are Dorchester Avenue-Broadway, Summer Street, or Massachusetts Avenue. Traffic to and from the west has similar but not so serious traffic operations problems. Such traffic can use Massachusetts Avenue to avoid the Artery Corridor, but all local street bypass routes eventually connect with the expressway network in the South Area.



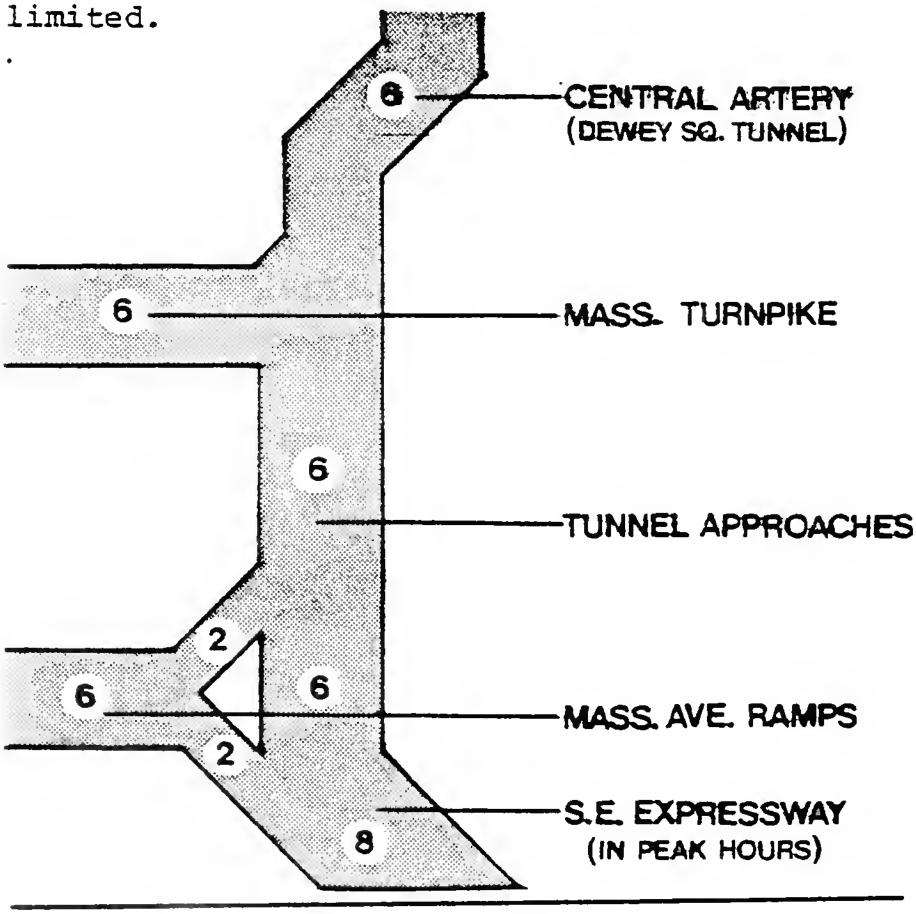
SOUTH AREA STREET SYSTEM

Figure 6

The cumulative effect of these problems produce a major impact on safety, operations and transportation service in the South Area. The major problem is the funnelling of traffic from expressways and arterial streets between the Massachusetts Avenue Interchange and the Massachusetts Turnpike into the 6 lane Dewey Square Tunnel. This section of the south area is inadequate to accommodate the heavy volume of traffic at acceptable operating levels.

For example, during the A.M. peak, traffic is allowed to use the shoulder of the Southeast Expressway. Figure 7 presents the lane configuration during the A.M. peak for inbound traffic. The reverse situation occurs during the evening peak.

The entire problem of lane imbalance on the Artery is magnified because of right-of-way limitations within the immediate Corridor, and the setting in a highly developed urban area where transportation impacts are severe and alternatives are limited.



SOUTH AREA EXPRESSWAY LANES

Figure 7

II.B.1.a. Highway and Tunnel Problems

The South Section of the Central Artery is a six lane facility extending from the Massachusetts Avenue Interchange to approximately the Northern Avenue on-ramp. The Section is split approximately in half with 50% being within a tunnel and the balance on viaduct. Typically, each roadway is 40 feet in width, having three 12-foot lanes with 2-foot lateral clearances on each side. There are neither shoulders nor breakdown bays on either the viaduct or within the tunnel. Auxiliary speed change lanes do exist between some entrance and exit ramps.

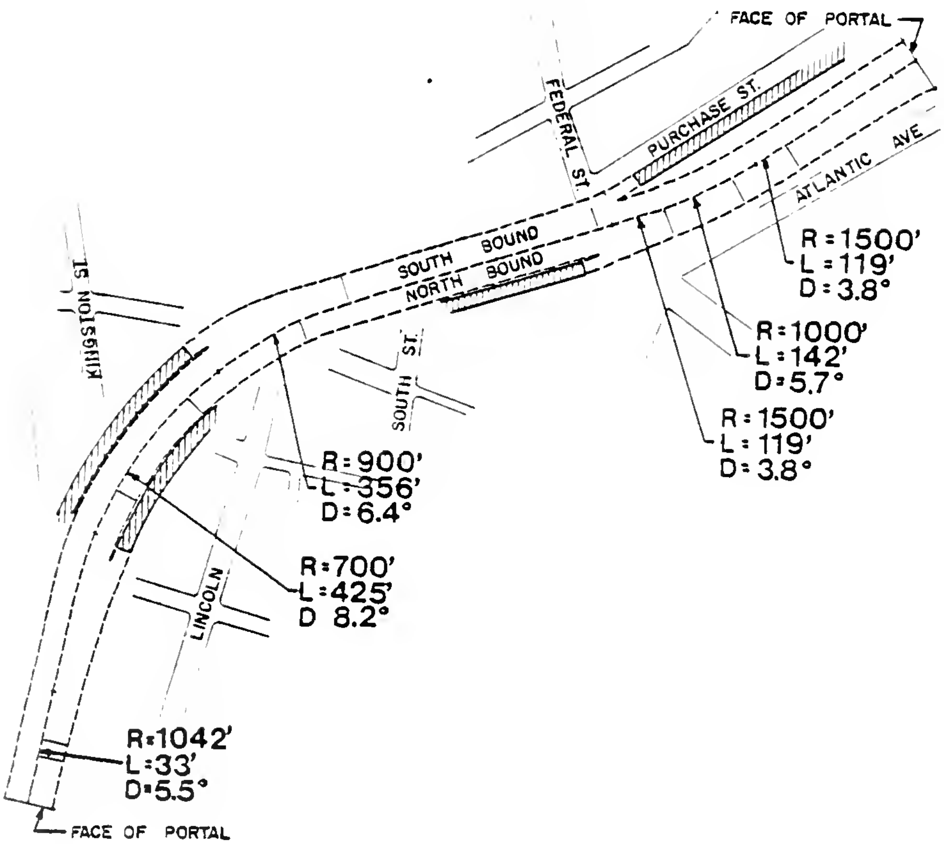
The 2500' 6 lane Dewey Square Tunnel is the only expressway link in the South Area between the highways to the south and the Central Artery giving access to Downtown and the north. It is the only portion of the Artery corridor that is currently in tunnel. The Dewey Square Tunnel poses the major constraints on the South Area in terms of its alignment, safety and capacity.

Between the Massachusetts Avenue interchange and the North portal of the tunnel there are seven ramps on the north bound roadway and eight on the southbound roadway. Ramp spacing varies between 700±' and 2500±' on the northbound roadway, and 770±' and 1450±' on the southbound roadway. Weaving maneuvers are generally one-sided weaves. Because of hazardous operational experiences in the past, one "off" ramp on the northbound tube has been permanently closed. In addition, during the morning peak, the Broadway "on" ramp south of the tunnel is closed.

Ramp spacing does not meet minimum design criteria. This item is particularly critical to operations on the facility. During peak hours this results in vehicles directly entering the main stream of traffi without the value of acceleration lanes or, when a speed change lane does exist between ramps, it is of insufficient length.

Critical geometrics within the south area are located within the tunnel. In general, both design and average highway speed on the Central Artery is 50 MPH. However, within the tunnel, design speed varies between 40 MPH and 50 MPH. Superelevation on curves within the tunnel varies between 0.01 and 0.015 feet per foot.

Not only are traffic operations affected by the variance in design speed in the tunnel, but also safety. The 40 MPH design section is part of a compounded curve. The balance of this curve has 50 MPH design speeds. Therefore, sight distance along the high speed lane of the south bound roadway changes along the curve from 350±' to 275±'. While not critical in peak hours this does introduce a deficiency in safety for those off peak hours when speeds approach 45-50 MPH. A similar situation exists in the outside lane of the northbound roadway throughout this compound curve section.



DEWEY SQUARE TUNNEL ALIGNMENT

Figure 8

II.B.1.b Tunnel Connections to Surface Streets

The original plan for the Dewey Square Tunnel relied on connections with downtown arterials to provide maximum distribution and collection services. In some cases the surface streets have been utilized as parallel frontage roads.

North of Dewey Square, Atlantic Avenue and Purchase Street form parallel frontage roads with ramps directly to and from the tunnel. These two streets connect with other local streets, but are limited in their usefulness because they extend for only four blocks through Downtown.

South of Dewey Square the tunnel is on an alignment which cuts diagonally across the grid pattern of surface streets. As a result the surface street pattern is ineffective in serving the collection and distribution functions which it was intended to serve.

Surface street changes have been proposed over the years to improve access between the tunnel and arterials, and to better serve new development. Closing segments of streets, directional changes, widening specific streets and new alignments for local streets have all been considered. Yet an effective overall plan continues to depend on changes to the deficiencies of the expressway system.

II.B.2 The Approaches to the Dewey Square Tunnel

The Artery Corridor immediately south of the Dewey Square Tunnel is the area where the effects of Dewey Square Tunnel problems are most seriously felt. Much of the congestion on this section is caused by the backup from the Dewey Square Tunnel. In addition, this area is critical because of the connections it provides between local streets, the Southeast Expressway, the Massachusetts Turnpike and Downtown.

Problems on the approaches to the Dewey Square Tunnel can be divided into two parts: those associated with the Massachusetts Turnpike interchange and those on I-93 south of the interchange.

.B.2.a The Massachusetts Pike Interchange

The Massachusetts Turnpike, built in 1965, connected to the Central Artery in the vicinity of South Station. The interchange was constructed on former rail yards, and property was taken from Chinatown to complete the ramp connections. Ramps were provided to connect to the Central Artery north and south, and to local streets such as Kneeland Street. These ramps were located in constricted space, as a result optimum geometric design could not be obtained.

The construction of this interchange connects with the Artery at the South portal of the Dewey Square Tunnel-- the main constriction of the South Area of the Artery Corridor. Volumes on the Turnpike in this area now approach 60,000 per day. More than half of the traffic is destined for the northbound roadway, requiring motorists to use the Dewey Square Tunnel or find alternative routes on local streets.

Capacity is the most serious problem at the Mass. Pike interchange. Volumes have been growing over time, and at present, the congestion in this area is one of the most serious in the Artery corridor. The capacity restriction is compounded by the lack of bypass facilities or parallel surface routes for spillover traffic.

II.B.2.b South of the Mass. Pike Interchange

The roadway section between the Mass. Pike interchange and the Massachusetts Avenue/Southeast Expressway is affected by the problems of the Dewey Square Tunnel and the Massachusetts Turnpike Interchange. Constructed as an elevated viaduct facility, this section is constrained by the lack of breakdown lanes, acceleration and deceleration lanes and adequate sight lines. As a result there is serious congestion during much of the day. Frontage roads have been provided but they are not continuous along the full length of the roadway. They lead to surface roadways which are discontinuous and also congested.

Certain of the surface roadways lead into residential neighborhoods, resulting in serious traffic disruption to the communities along the South Area of the Corridor. Trucks--particularly those carrying dangerous cargoes--leave the Expressway on these surface streets and travel through residential streets and the edge of downtown, further adding to traffic operation problems and congestion. At the Massachusetts Avenue interchange with the Artery Northbound, a major ramp enters from the left, compounding the difficulties on the Artery. This interchange was designed for service to the Inner Belt, which is no longer planned for construction.

II.B.3 Related Problem Areas

The congestion of the South Area of the Artery Corridor causes many drivers to attempt to avoid this section of the expressway network. They do so by seeking local streets which do not have the degree of congestion which is usually present on the Artery. Limited alternatives are available for such spillover traffic. The three major points through which this spillover traffic must pass are: (1) the Massachusetts Avenue interchange; (2) Summer Street Bridge; (3) the Broadway Bridge.

II.B.3.a Massachusetts Avenue Interchange

The major operational problem at this interchange is the connection between the Southeast Expressway and the local arterial streets in the South End. At present, the interchange connects directly with directional ramps to and from the expressway to Massachusetts Avenue. This interchange was designed for interstate traffic connecting to the proposed Inner Belt, which has been dropped from further consideration for construction.

It would have served traffic between expressways with 3 lanes in each direction; these lanes now provide a means for motorists to avoid the expressway network and travel through residential streets in the South End as alternative means of reaching Downtown.

II.B.3.b Summer Street Bridge

The Summer Street Bridge across the Fort Point Channel primarily serves access between Downtown and the industrial and residential areas of South Boston. Because it provides connections between several of the South Corridor major arterials and Downtown, it is used as a bypass route for traffic attempting to avoid the congestion of the expressway network, particularly during peak hours. The problems with it are that it is inadequate from a traffic operations viewpoint and it has heavy impacts on residential South Boston. It is not an adequate alternative or supplement to the Southeast Expressway connections in the south corridor. With expansion of the port activities in the South Boston portion of the Boston Naval Shipyard, and the expansion of associated truck traffic, the potential for additional truck traffic will add to the present transportation problems of Summer Street.

II.B.3.c Broadway Bridge

The Broadway Bridge is a part of the continuous parallel arterial street system in the south area adjacent to the Southeast Expressway. It forms a continuous link with Morrissey Boulevard, Old Colony Boulevard, Columbia Road and other arterials. It intersects the Artery corridor just south of the Dewey Square Tunnel. At this point, Broadway diminishes in capacity and system connections, causing traffic to divert onto the Artery in order to connect with other principal arterials in the Downtown area. Traffic avoiding the Southeast Expressway using the series of parallel arterials must eventually cross the Broadway Bridge and either enter the Artery flow, or find alternative Downtown streets for connections.

II.C SOUTH AREA TRAFFIC CHARACTERISTICS

II.C.1 Design Deficiencies

A number of design deficiences have been identified in the present South Section of the Central Artery, all of which tend to diminish service capacity, operating levels, and safety. The design areas that have caused problems may be categorized as follows:

*Shoulders
*Ramps - acceleration and deceleration lanes
*Curves and grades
*Sight distances
*Connections to surface streets

In the remainder of this section, these aspects of highway design are taken up in terms of design standards, and also as general problems of the Central Artery South Section design.

II.C.1.a Shoulders

Under ideal construction conditions, it is usually regarded as desirable that modern expressways have continous paved shoulders on both sides of the paved lanes. As rights-of-way become more constricted, particularly in the denser urban areas, this standard is progressively modified. The first fall-back position is to have intermittent shoulders. The second is to have no shoulders.

As indicated above, in the case of the South Section of the Central Artery, none of these standards is achieved. Both in the Dewey Square Tunnel and on the viaduct sections there are no shoulders, no breakdown lanes, and no breakdown bays. The Massachusetts Turnpike interchange area is the only place in the Central Artery South Section where any provision is made for instances of vehicles leaving the main travel lanes for breakdown or other reasons. In that section of roadway, there are several very limited sections of pavement off the main travel lanes.

The result of this, as indicated above, is that even the most minor breakdowns cut one-way Central Artery capacity by one-third. Accidents are more frequent than they would be otherwise, and when they do take place, there is no ready opportunity either for taking disabled vehicles to the side of the road or for traffic to detour around. Altogether, the lack of breakdown facilities and/or shoulders is a severe design deficiency for the Central Artery South Section.

II.C.1.b Ramps - Acceleration and Deceleration Lanes

The original plan for the Central Artery South Section relied on numerous connections with downtown arterial streets to provide maximum distribution and collection services. This caused a problem in terms of modern expressway design, partly because it created many entry and exit points to and from the Artery with short intervals between them, and also because it made it impossible for adequate acceleration and deceleration lanes to be provided. Only in a few cases were any acceleration and deceleration lanes provided at all, and typically these are of inadequate length.

In modern expressway design, interchanges should be as infrequent as possible - preferably a mile or more apart, and, where the design speed is 50 MPH, acceleration and deceleration lanes should respectively be a minimum of 1,000 feet and 450 feet long. The distance between an entry and a subsequent exit should be no less that 650 feet. Also, it is generally desired that ramps enter and exit from and to the right.

In the case of the Central Artery it would not be possible under any circumstances to meet the standard for distance between interchanges and still allow necessary expressway connections and collection-distribution functions. Further, it would be difficult to fully meet the acceleration, deceleration, and ramp spacing standards. Nonetheless, the standards have been breached more in the Central Artery South Section than necessary and desirable under today's conditions.

Ramp spacing is shown in Figure 9 for southbound and northbound roadways of the South Section. As shown, there are a total of ten ramps southbound, and nine ramps northbound in the less than two miles of the section. Ramp spacing varies between 450 ft. and 1,450 feet southbound, and between 500 and 2,800 feet northbound. In three cases it would be physically impossible to meet the on-off standard because of ramp spacing. In two cases ramps exit to and enter from the left. As indicated above, acceleration and deceleration lanes are rarely provided at all. In fact, if all the existing ramps were to have acceleration and deceleration lanes of standard length, such lanes would occupy approximately one-third of the length of the Central Artery South Section. As such, a substantial portion of the Artery's length would have an extra lane in each direction only for the purpose of acceleration and deceleration. As the facility presently operates, the right-hand travel lane largely performs this function, leaving an effective total of two travel lanes in each direction.

To avoid the worst ramp problems, in two instances where an exit follows an entrance with too little space in between, one of the ramps has been closed either at peak hours or permanently.[1] The northbound Broadway on-ramp is closed at peak hours, and the northbound Lincoln Street off-ramp

[1]The explicit reason for closure was not inadequate space between ramps. In the case of the Broadway entry the ramp was closed in the AM peak because Central Artery traffic was attempting to avoid the Dewey Square (cont'd)

in the Dewey Square Tunnel is closed permanently. Even with these changes, however, lack of acceleration and deceleration lanes makes access to and egress from the Central South Section a difficult and dangerous proposition.

II.C.1.c Curves and Grades

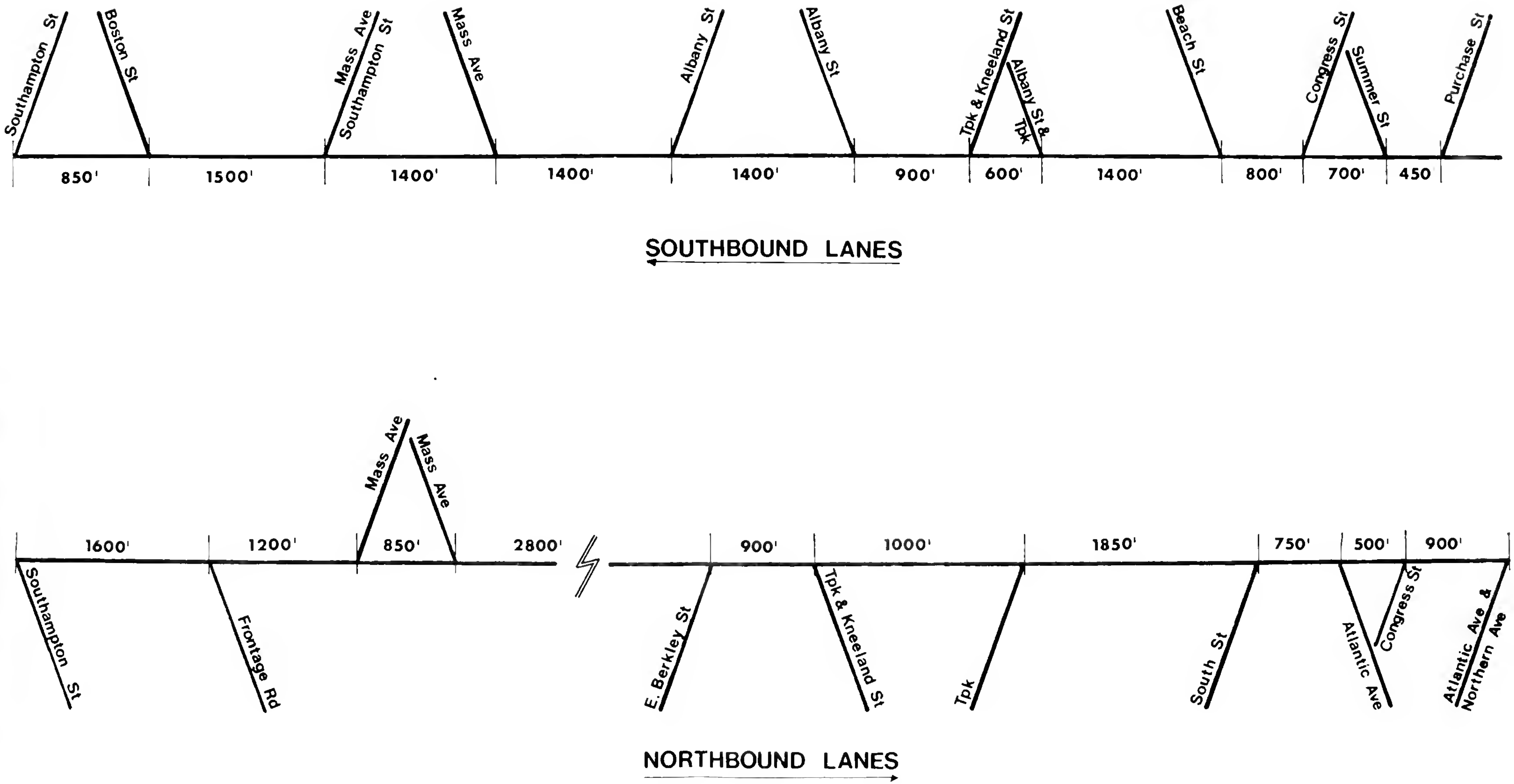
Design criteria for curves and grades on an urban expressway with a design speed of 50 MPH call for a minimum radius of curvature of 830 feet, and a maximum grade of 4 %. In the Central Artery South Section, these standards are generally observed, but they are breached in certain instances in the Dewey Square Tunnel. There, a compound reverse curve has a minimum radius of 700 feet, and a corresponding design speed of 40 MPH. This is a more serious problem in the confines of a tunnel than it would be in the open, because there is less room for error. The tunnel also has minor grade problems. At both tunnel portals, there are grades of approximately 5%.

II.C.1.d Sight Distances

Sight distances can become a problem either for horizontal or vertical curves. In the case of a horizontal curve, the problem is seeing an obstacle around the corner, and having adequate time to stop. In vertical curves, the problem relates to being able to see over the crest of a hill, or occasionally, under the roof of a tunnel where it switches from going down to going up. In the case of 50 MPH facility, a sight distance of 350 feet for horizontal and vertical curves is considered adequate.

As applied to the Central Artery South Section, sight distance is a problem in one place: the 40 MPH section of the Dewey Square tunnel. In that section, sight distances are restricted to 275

(continued)
Tunnel queue by exiting the expressway at Southhampton Street, traveling along the Frontage Road, and then re-entering the expressway at Broadway. In the case of Lincoln Street, ramp traffic was backing up into the Dewey Square tunnel and producing Central Artery blockages.



RAMP SPACING DIAGRAM
CENTRAL ARTERY
SOUTH AREA

Figure 9

II.

II.

feet for the inner lane of the southbound roadway and the outer lane of the northbound roadway. In neither direction is the problem of concern during peak periods when traffic moves slowly. At off-peak periods, however, traffic speeds in the tunnel approach 45-50 MPH and sight distances do cause problems when traffic suddenly backs up because of a breakdown or for other reasons.

II.C.1.e Connections to Surface Streets

In ideal urban expressway design, access and egress are promoted by the use of parallel one-way frontage roads on either side of the main expressway facility. For entry to the expressway, the frontage roads provide relatively unimpeded access to the ramps. For egress, the frontage roads provide capacity behind intersections and traffic signals so that traffic exiting the expressway is less likely to back up into the expressway itself. Also, in times of emergency or expressway repairs, frontage roads can act as reasonably efficient detours.

North of Dewey Square, Atlantic Avenue and Purchase Street form parallel frontage roads with ramps directly to and from the tunnel. These two streets connect with the rest of the downtown street network, but are somewhat limited in their usefulness as frontage roads because they are adjacent to the Central Artery for only a four block stretch.

South of Dewey Square, a roadway on top of the tunnel acts in part as a frontage road. This function is also limited, however, because in this area the Artery is on an alignment which cuts diagonally across the grid pattern of surface streets. In this area, various plans for surface street changes have been proposed over the years to improve access between the tunnels and surface streets, and to better serve development. Yet, an effective overall plan appears to depend primarily on changes in the Artery itself.

South of the Dewey Square Tunnel, the Artery design is at least in part standard with regard to frontage roads. Southbound, Albany

Street acts as a frontage road from the tunnel portal area to the Massachusetts Avenue interchange. Northbound, a frontage road exists from Southampton Street south of the Central Artery, to the Massachusetts Turnpike interchange.

II.C.2 Traffic Characteristics

A complete study of present traffic characteristics in the South Area would include information on traffic origins and destinations, volumes, service levels, and accidents both for expressway and local street travel. At the present time, South Area corridor level origin-destination data are unavailable, and information on traffic volumes, service levels, and accidents has been compiled only for the Central Artery in the South Area. Thus, in this section, detailed traffic analysis is restricted to consideration of the South Section of the Central Artery. Traffic characteristics for local South Area streets are treated only as broad general flows. In most of the analysis, data are from regular counts of the DPW. In certain cases, DPW data have been modified by new information collected in 1977 as part of the Southeast Expressway Downtown Express Lane Project.

II.C.2.a Volumes

As indicated above, the basic traffic problem in the South Area is insufficient expressway and local street capacity to handle existing amounts of traffic at reasonable levels of service. This is seen in terms of substantial peak period queuing on the Central Artery south of the Dewey Square Tunnel, and in terms of extreme peak period congestion of local and arterial streets leading into downtown Boston from the Boston South End and from South Boston. The problem of downtown-destined and through traffic avoiding the Dewey Square bottleneck by traveling on neighborhood streets is disruptive to local neighborhoods. During peak periods, a considerable amount of downtown-destined traffic exits west from the Central Artery at the Massachusetts Avenue interchange, and then goes generally north toward the central area of Boston via Albany Street, Washington Street, Tremont

Figure 10

Average Daily Traffic (ADT) in South Area
Entering, Exiting and On the Artery

SOUTHBOUND

Location	Entering	Exiting	On Artery
South of High Street	-	-	57,100
Purchase Street Entrance	13,350	-	
			70,450
Summer Street Exit	-	8,900	
			61,550
Congress Street Ent.	5,350	-	
			66,900
Beach Street Exit	-	3,400	
			63,500
Albany St/Turnpike Exit	-	15,150	
			48,350
Kneeland St/Turnpike Ent.	16,000	-	
			64,350
Albany St. Exit	-	4,100	
			60,250
Albany St. Ent.	13,100	-	
			73,350
Mass. Avenue Exit	-	8,900	
			64,450
Mass. Avenue Ent.	3,050	-	
South of Mass. Avenue			67,500

NORTHBOUND

Location	Entering	Exiting	On Artery
South of Mass. Ave.	--	-	56,100
Mass. Avenue Exit	-	7,100	
			49,000
Mass. Avenue Ent.	5,850	-	
			54,850
E. Berkeley St. Ent.	8,450	-	
			63,300
Kneeland St/Turnpike Exit	-	16,900	
			46,400
Turnpike/Broadway Ent.	16,700	-	
			63,100
South Station Ent.	8,900	-	
			72,000
Northern Ave. Exit	-	16,000	
North of Northern Ave.			56,900

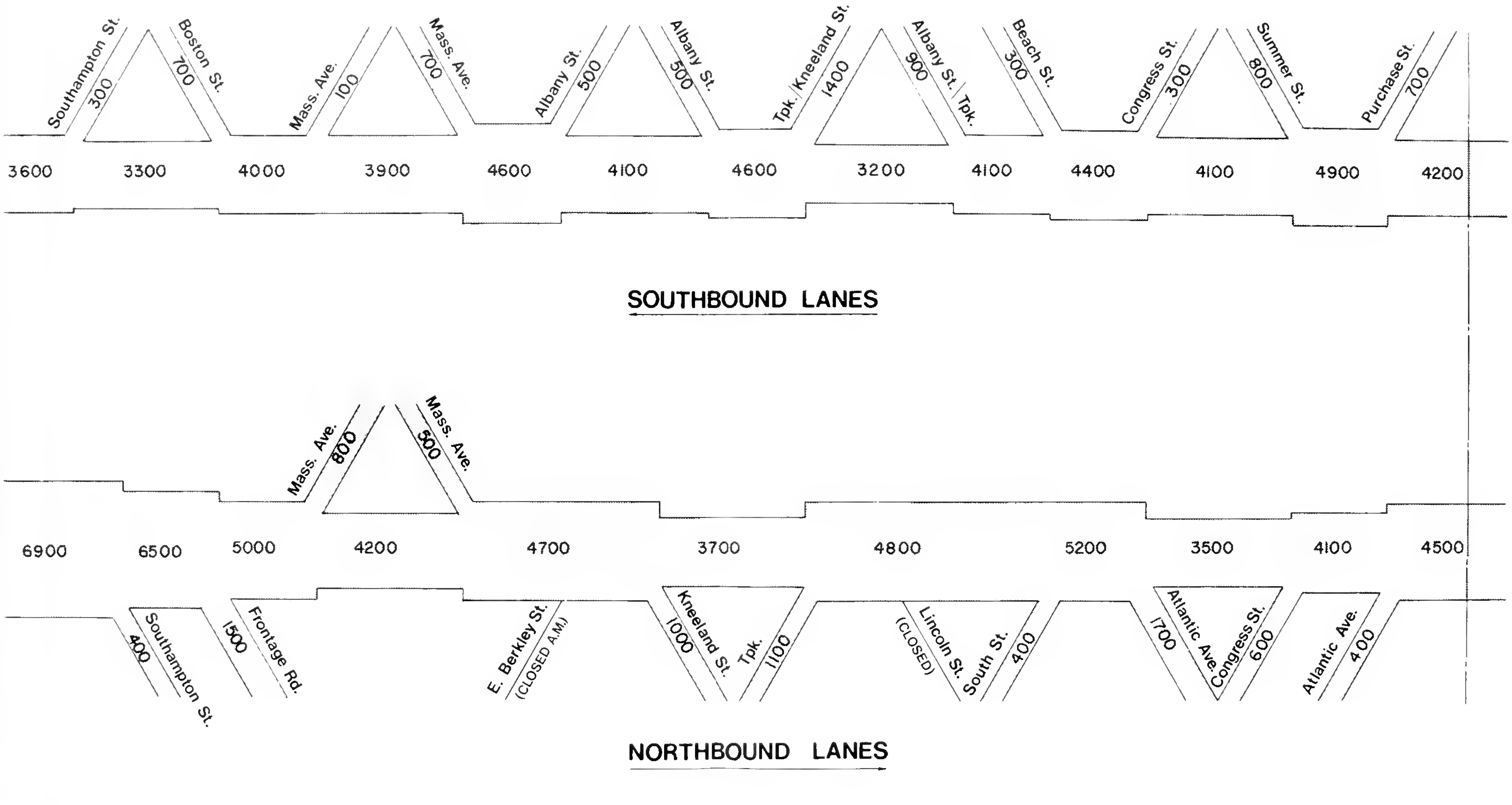
Source: 1972 counts by the Mass. Dept of Public Works

Street, or Columbus Avenue. This traffic avoiding the Central Artery substantially worsens peak period traffic conditions throughout the South End of Boston.

Similarly, other traffic exits from the expressway north or south of Southampton Street to travel to or through the Boston Central Area via South Boston, thus substantially adding to local traffic in that area. In the South Boston case, the primary arterial streets used are L Street, Dorchester Avenue, and the expressway frontage road. L Street may be used to go to Summer Street, Congress Street, or Northern Avenue, all of which cross Fort Point Channel into downtown Boston north of South Station. From Dorchester Avenue, Broadway and Berkeley Street may also be used to get to downtown. These latter streets are similarly the normal routes to downtown Boston from the frontage road.

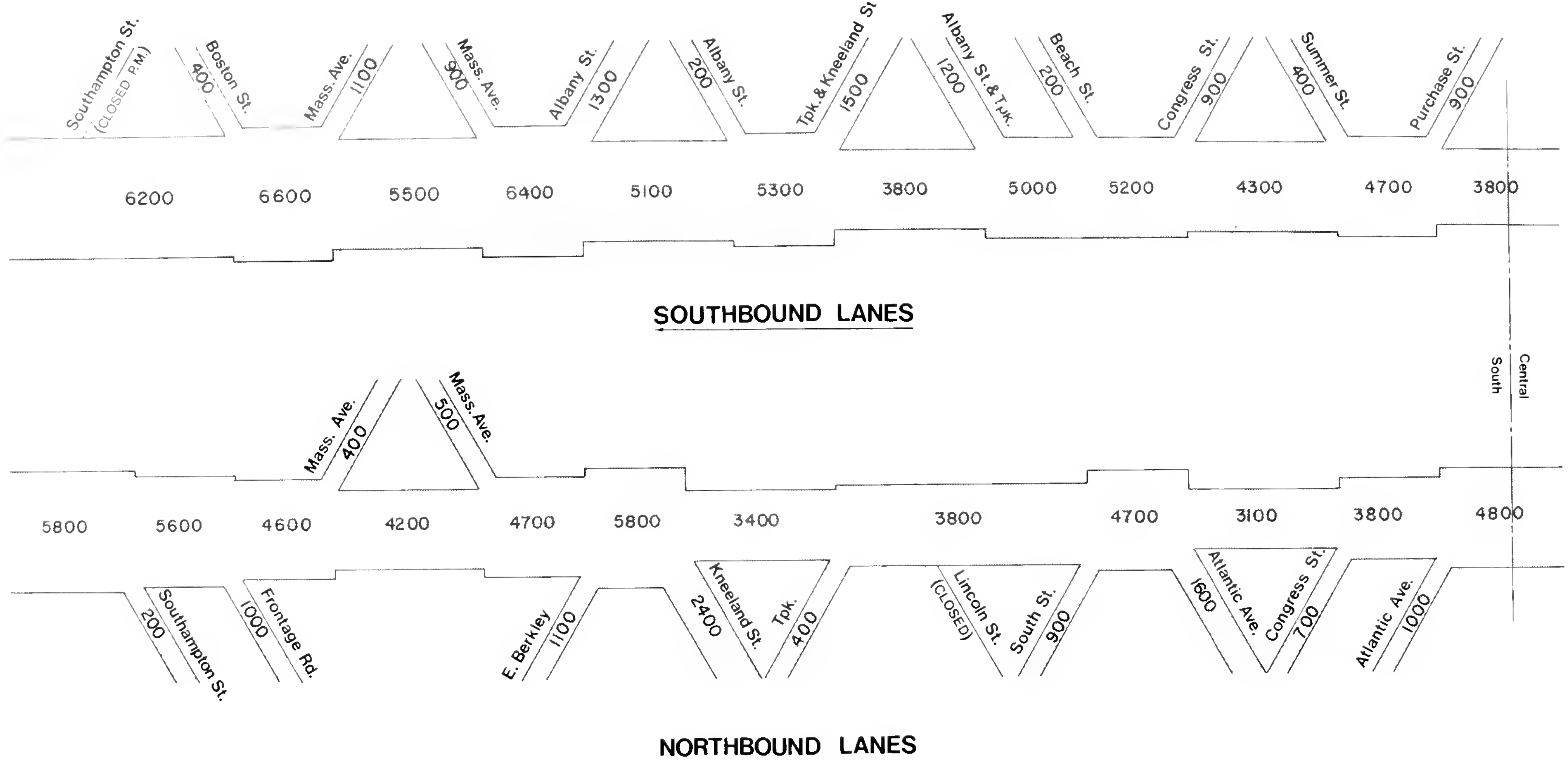
A further problem is caused by the fact that a number of these local and arterial streets come together in the South Area near the Massachusetts Turnpike interchange. Broadway and Berkeley Street both intersect the streets coming up from Massachusetts Avenue, and Broadway, itself, has a smaller capacity north of the Turnpike interchange than it does south of it. Similarly, Albany Street is one-way southbound in the vicinity of the interchange. For these reasons, not only does the expressway system have a bottleneck in the South Area, but the local and arterial streets do as well.

The relationship between local and expressway traffic may not be seen directly, but may be inferred from the expressway traffic volumes shown in Figures 11 and 12 for the A.M. and P.M. peaks. In Figure 11, for the A.M. peak, it is seen that northbound expressway traffic diminishes from 6,900 vehicles per hour south of Southampton Street to 4,800 vehicles per hour in the Dewey Square Tunnel. Including the additional 1,100 vehicles per hour from the Turnpike this amounts to a total diminishment of 3,200 vehicles per hour or 40% of a total of 8000. Although a significant portion of the net 3,200 vehicles per hour exiting the expressway between Southampton



1976 A.M. PEAK VEHICLES PER HOUR: CENTRAL ARTERY SOUTH AREA

Figure 11



1976 P.M. PEAK VEHICLES PER HOUR: CENTRAL ARTERY SOUTH AREA

Figure 12

Street and the tunnel probably have destinations within the South End and South Boston, it seems likely that much of this traffic is either downtown-destined or through traffic. This may be seen by the fact that only 1,900 vehicles per hour leave the expressway southbound between the tunnel and Southampton Street during the A.M. peak. If there were no substantial downtown-destined and through component to northbound traffic on local streets in the South Area, north and southbound exiting expressway volumes would presumably be roughly equal.

Two other relevant expressway traffic characteristics may be seen in Figure 11. The first is that the actual minimum volume northbound on the Central Artery South Section is not in the tunnel, but rather between the Kneeland Street exit south of the tunnel, and the Turnpike entry, also south of the tunnel. This does not demonstrate a particular constriction at this point on the Central Artery. Rather, it shows the effects of traffic leaving the tunnel queue, prior to entry of the Turnpike traffic. The second traffic characteristic seen is that volumes on the southbound lanes of the Artery during the A.M. peak show much less variation than those on the northbound lanes. They vary only between 3,200 and 4,900 vehicles per hour. The difference between northbound and southbound roadways reflects the absence of traffic with a downtown-destined component in the southbound lanes.

As shown in Figure 12, the P.M. peak is essentially the reverse of the A.M. peak. Southbound, peak hour traffic builds up from 5,000 vehicles per hour passing through the Dewey Square Tunnel, to a total of 6200 at Southampton Street. Northbound, there is evidence of P.M. queuing, with 6,700 vehicles, 5,800 from south of Southampton Street, and 400 from the Turnpike, diminishing to only 3,800 vehicles going through the tunnel. From this it is evident that local streets in the South End and South Boston are being used as detours around the Dewey Square Tunnel both in the A.M. and P.M. peaks.

II.C.2.b Service Levels

For purposes of analysis and comparison, a number of levels of service have been defined by the Highway Research Board to describe the operations of highways under a variety of traffic conditions. These levels of service, as defined for expressways, range from "A" with free flow, no congestion and speeds in excess of 60 MPH, to "F" where demand cannot be satisfied, and traffic is "stop-and-go." Figure 13 gives descriptions of traffic flow, typical speeds, and what is known as the Volume/Capacity Ratio for levels of service "A" through "F" as applied to expressway facilities. Ideally, it is desired that highways be designed so that they can operate at a "C" level of service for the thirtieth heaviest hour of the year. Also, capacity is defined as the amount of traffic that a highway can handle in an hour at level of service "E"/ The design volume is the traffic estimated to use a facility daily during the design year - usually 20 years from the completion of construction.

The Central Artery South Section, as a six lane facility, has a basic hourly capacity of 5530 vehicles per hour in each direction. Its corresponding design volume is 77,000 vehicles per day. (At present it is carrying 135,000 vehicles per day.) Because of the design problems of the Dewey Square Tunnel area, however, the actual capacity for level "E" service, is less that 5530 vehicles hourly. The excessive grades at the tunnel portals alone have the effect of reducing "E" level capacity to 4,260 vehicles per hour in each direction. Similarly, the closely spaced ramps, lack of acceleration and deceleration lanes, excessive curves, and lack of breakdown facilities or shoulders reduce capacity even more. It is therefore not surprising that the Dewey Squre tunnel area operates at level "F" for a number of hours each day, and that substantial queues develop south of the tunnel during peak periods. At the present time, operating speeds for queue peak hours range between 0 and 27 MPH, and average 12 MPH.[2]

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[2] Southeast Expressway Downtown Express Lane Project, April, 1977.

The fact that both directions of the Dewey Square tunnel handle volumes of near to or about 5,000 vehicles per hour under forced flow conditions during peak hours, indicates that the absolute capacity of the Dewey Square Tunnel, as presently constituted, is about 5,000 vehicles per hour in each direction. This is obviously substantially less than the volume of traffic that would use the tunnel instead of detouring through local streets, if the tunnel had more capacity.

Figure 13

EXPRESSWAY SERVICE LEVELS

Level of Service	Description	Speed	Volume/Capacity Ratio
A	Free Flow	> 60	.35
B	No Congestion	55-60	.50
C	Light Congestion	50-55	.57
D	Moderate Congestion	40-50	.68
E	Heavy Congestion	30-35	1.00
F	Demand Cannot be Satisfied	Stop and Go	> 1.00

Source: Highway Capacity Manual, 1965, Highway Research Board

II.C.2.c Accidents

Fully access controlled freeways are the safest highway facilities we can build. Based on national statistics, they are nearly twice as safe as the average of other facilities, having a fatality rate of about two and one-half deaths per one hundred million miles of vehicle travel, as compared with the national average of four deaths per hundred million miles of other facilities.[3] Urban expressways are even safer than rural ones, primarily because they handle extremely heavy travel volumes. The national fatality rate in 1971 for fully access controlled urban expressways was 1.00 deaths per one hundred million miles.[4] Accident and injury

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3 In house study of accident data by E.N. Kashuba for the Highway User Investment Study, 1971, F.H.W.A.

4 Fatal and Injury Accident Rates on Federal Rates on Federal Aid and Other Highways Systems, 1975, F.H.W.A.

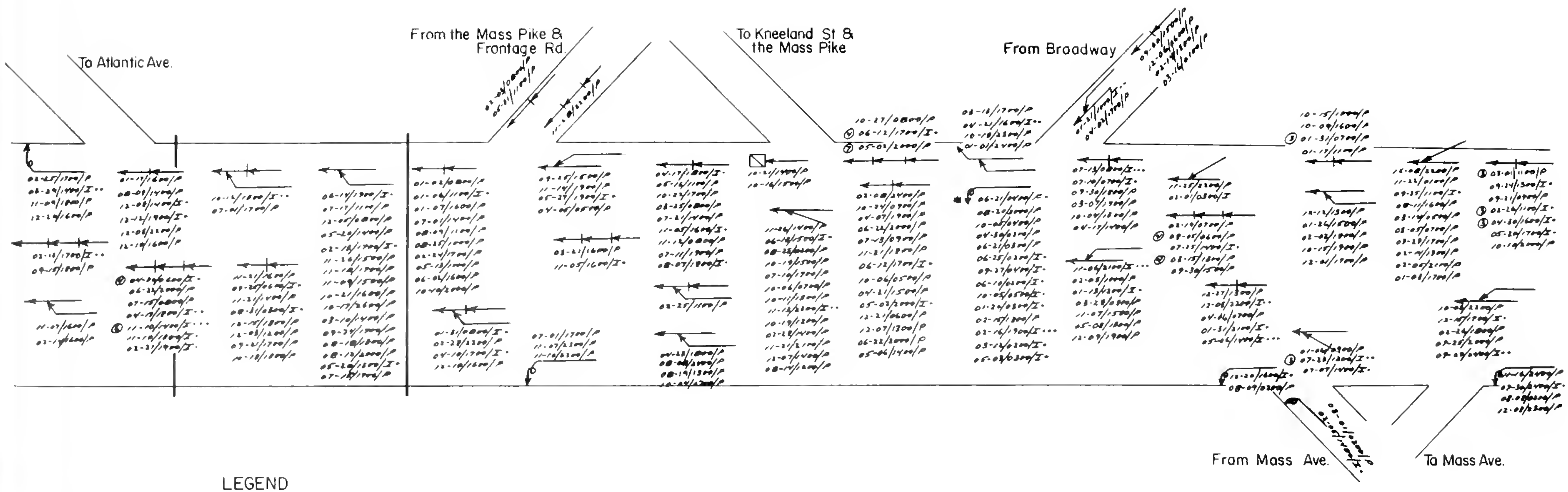
statistics are similar. Both in accidents and injuries, access controlled expressway facilities are much safer than other highways.

As measured by these indices, the Central Artery South Section is not a safe facility. During 1975, it experienced a total of 449 reported accidents, involving 190 injuries and three fatalities. As shown in Figure 14, the accident rate of 505 accidents per one hundred million vehicle miles was more than twice the national average for urban expressways carrying in excess of 76,000 vehicles per day. The injury rate, at 214 per one hundred million vehicle miles was almost twice the national rate of 134. And the fatality rate of 3.38 in 1975 was over three times the national average. Because the 1975 rate is based on only three fatalities, it might appear to be a questionable statistic because of small sample size. But over a longer time period, fatalities still average over twice the national rate, with a total of eight fatalities having been experienced in traffic accidents on the South Section of the Central Artery during the years 1973-1976.

Figure 14: Comparative Accident Rates and Fatality Rates for Fully Access Controlled Expressway Facilities: Central Artery South Section and National Statistics

	Central Artery South Section (1975)	U.S. Urban Expy's with Six or More Lanes and > 76,000 A.D.T. (1971)[5]
Accidents	505	239
Injuries	214	134
Fatalities	3.38	1.00

[5] Per one hundred million vehicle miles of travel. National statistics from in-house study of accident data by E.N. Kashuba for the Highway User Investment Study, 1971, Federal Highway Administration.



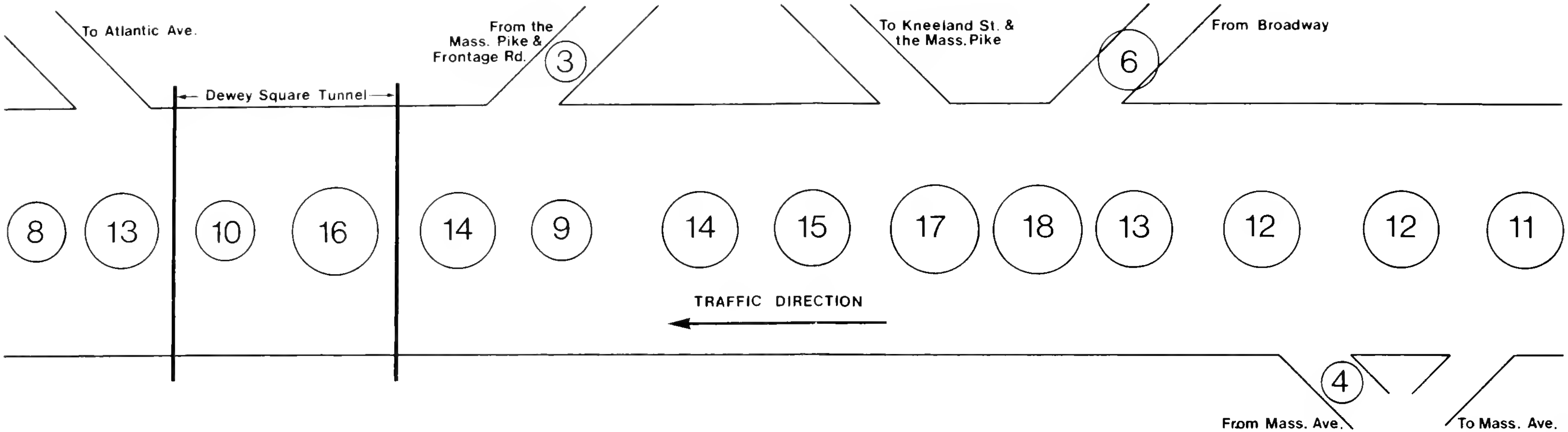
LEGEND

	Rear End
	Angle
	Lost Control or Ran Off Road &/or Hit Fixed Object
●	Injury
*	Fatality
	Parked or Stalled Vehicle
○	Pedestrian
④	No of Vehicles (if more than 3)
03/11	March 11, 1975
1700 (hrs)	5:00 p m
P	Property Damage
I	Injury

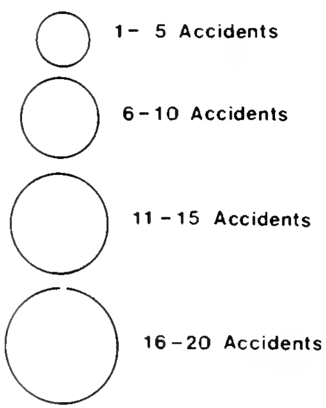
NOTE: Of the 449 identified accidents in the South Section of the Central Artery, 382 have been plotted (210 Northbound, 172 Southbound). There is insufficient data to plot the remaining 67 accidents (i e Date, Specific Location, Type of Accident, Etc)

COLLISION DIAGRAM:
NORTHBOUND CENTRAL ARTERY SOUTH AREA

Figure 15A



LEGEND:

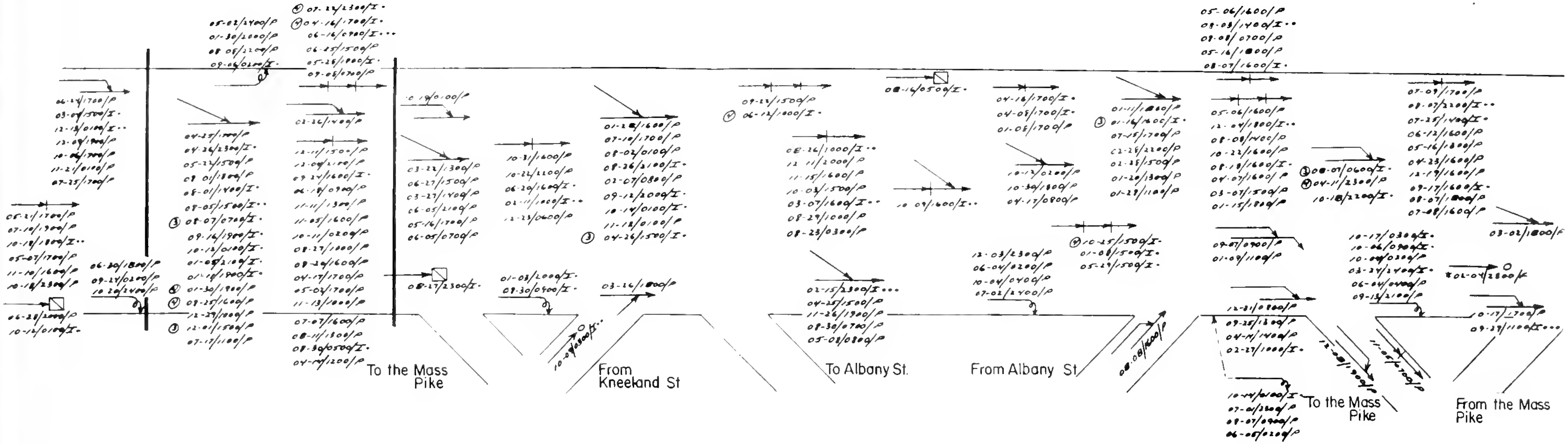


NOTE:
Of the 449 identified accidents in the South Section of the Central Artery, 382 (about 85%) have been plotted. There is insufficient data to plot the remaining 67.

ACCIDENTS BY LOCATION: CENTRAL ARTERY SOUTH SECTION, 1975-NORTHBOUND

ACCIDENTS BY LOCATION
CENTRAL ARTERY
SOUTH AREA

Figure 15



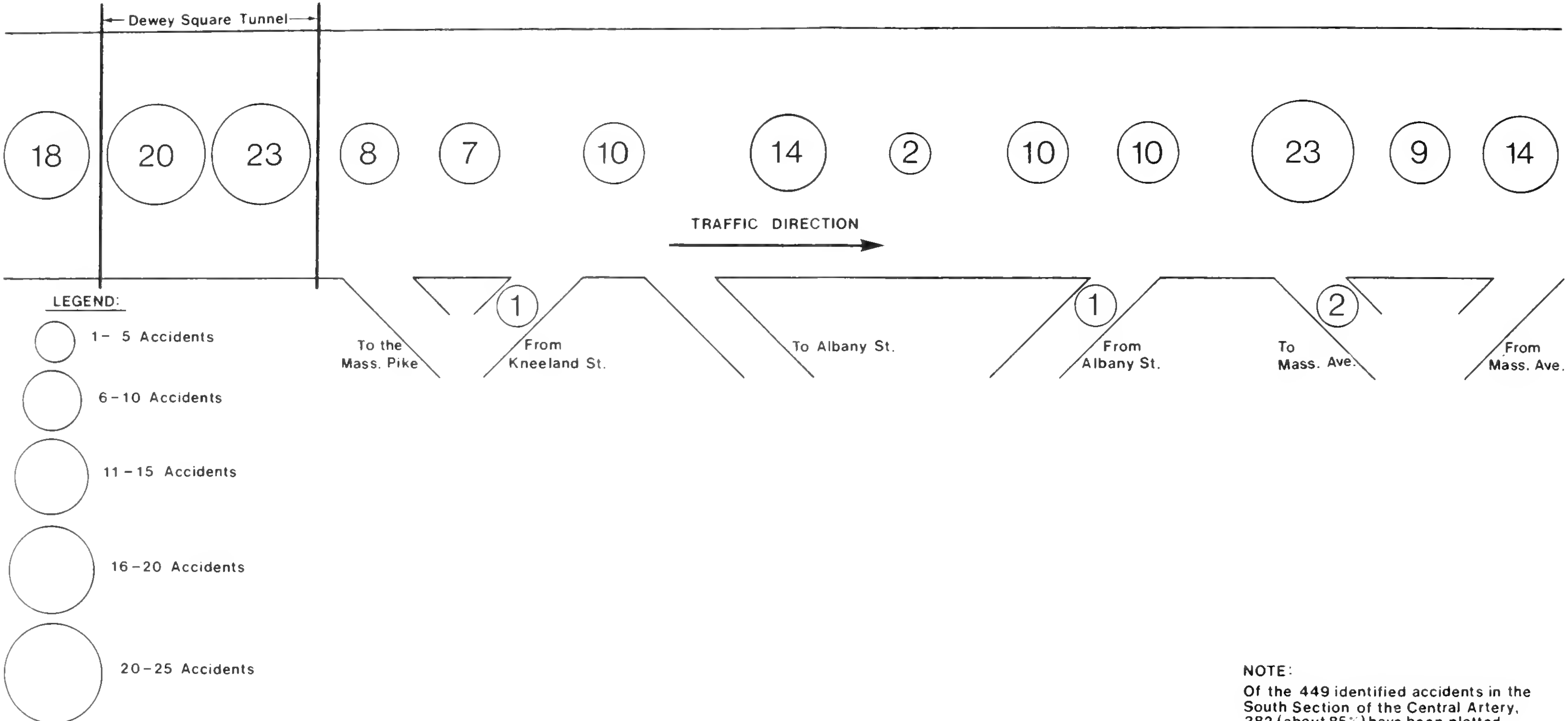
LEGEND

	Rear End
	Angle
	Lost Control or Ran Off Road &/or Hit Fixed Object
●	Injury
*	Fatality
	Parked or Stalled Vehicle
○	Pedestrian
④	No of Vehicles (if more than 3)
03/11	March 11, 1975
1700 (hrs)	5:00 p.m.
P	Property Damage
I	Injury

NOTE: Of the 449 identified accidents in the South Section of the Central Artery, 382 have been plotted (210 Northbound, 172 Southbound). There is insufficient data to plot the remaining 67 accidents (i.e. Date, Specific Location, Type of Accident, Etc.)

COLLISION DIAGRAM:
SOUTHBOUND CENTRAL ARTERY SOUTH AREA

Figure 16A



ACCIDENTS BY LOCATION: CENTRAL ARTERY SOUTH SECTION, 1975 – SOUTHBOUND

NOTE:
Of the 449 identified accidents in the South Section of the Central Artery, 382 (about 85%) have been plotted. There is insufficient data to plot the remaining 67.

ACCIDENTS BY LOCATION
CENTRAL ARTERY
SOUTH AREA

Figure 16

Accidents by location are shown for the South Section of the Central Artery in Figures 15 and 16 which are respectively, for northbound and southbound Artery roadways. As can be seen in Figure 15, northbound there are two areas on the roadway where there are more accidents than elsewhere. One is just before and just after entry to the Dewey Square Tunnel. Most of these accidents are related to merges from the Massachusetts Turnpike, and driver uncertainties entering the tunnel. The other heavy accident area is the Artery section between the Massachusetts Avenue interchange, and the Kneeland Street and Massachusetts Turnpike exit. Here the problems have primarily to do with weaving movements from the Massachusetts Avenue entry, to the Kneeland and Turnpike exit. They also have to do with with merges from the Broadway entry ramp, and with the tunnel queue. There are substantial numbers of accidents throughout the length of the northbound roadway of the Artery's South Section. This is because of the general problem of heavy Artery traffic volume, long queues, the many ramps, the lack of adequate acceleration and deceleration lanes, and the lack of shoulders or breakdown lanes or bays.

As seen in Figure 16, the situation southbound is similar to that northbound. The highest numbers of accidents happen in the Dewey Square Tunnel and near the Massachusetts Avenue interchange. Tunnel problems probably relate mostly to design standards of the tunnel, and to weaving movements being made prior to leaving the Artery at the Turnpike. At the Massachusetts Avenue interchange area, the problem is most likely due in major part to the conflicts between traffic entering from Albany Street, and traffic desiring to leave at the Massachusetts Avenue interchange.

Figure 17 shown accidents by type for the South Section of the Central Artery. As can be seen, both northbound and southbound, rear-end and angle accidents occur in almost equal numbers, and amount to about 85% of the total. This is a direct result of the two outstanding problems of the Central Artery South Section: inadequate capacity and insufficient merging opportunities. The rear-end accidents are in large measure the result of heavy stop-and-go queued traffic. The angle accidents are the results of overly frequent ramps, and lack of acceleration and deceleration lanes.

Even the remaining 15% of the accidents can in considerable measure be attributed to overly heavy traffic and inadequate merging opportunities. In most of these cases the accident consisted of a single vehicle running off the road and into the cement or metal roadside barrier. In many cases this was because the driver was unable to merge into traffic, or was driven into the side of the road by another automobile preparing to exit.

Figure 17
ACCIDENTS BY TYPE: CENTRAL ARTERY SOUTH SECTION, 1975

Accident Type	Northbound		Southbound	
	Number	Per Cent	Number	Per Cent
Rear End	92	44%	72	42%
Angle	87	41%	70	41%
Other	31	15%	30	17%
Total	210	100%	172	100%

Totals here represent only about 85% of actual reported accidents. Insufficient data were included in reports for the other 15% to allow dividing into categories.

Several further comments are relevant as regards accidents. First, it is worthwhile noting that 68% of the accidents on the Artery's South Section involved property damage only, and 84% were multiple vehicle accidents. This is again a result of heavy traffic, peak period queueing with stop-and-go traffic, and inadequate opportunities for merging and weaving.

Second, injury producing accidents occurred in much higher proportions during the period from 9 PM to 5 AM than during the day. All but one of the fatal accidents occurred during the nighttime hours, and injury producing accidents occurred at a 50% higher rate during this time. With substantially reduced volumes during the night off-peak period, vehicle speeds are higher thereby increasing the probability of injury during a crash. This alone, however, does not explain the high fatality and injury rates during the 9 PM-5 AM period. The prevailing higher speeds, together with the sub-standard design features of the roadway offer a more satisfactory explanation.

Finally, the accidents considered here represent only reported accidents. Experience throughout the U.S. has shown that only 20-40% of property damage-only accidents are normally reported to public authorities. Many researchers suggest that to compensate for this under-reporting, property damage-only accidents should be adjusted. In the absence of more precise information on the degree of under-reporting, multiplying the reported accidents by a factor of 2.5 (assuming a 40% reporting level), would yield a total of 904 accidents for the Artery's South Section, 760 having property damage only, and 144 involving injury or fatality.

II.D. Environmental Conditions

Highway construction in the South Area of the Central Artery Corridor can be expected to have environmental impacts related to air quality, noise, and water quality. In this section, these three indices of environmental conditions are assessed in terms of qualitative and quantitative measures, and then general statements are made regarding potential impacts that might result from future South Area construction.

II.D.1 Air Quality

The Federal Environmental Protection Agency has established ambient air quality standards for carbon monoxide, hydrocarbons, and oxides of nitrogen, all of which are pollutants produced through the use of automobiles. Carbon monoxide and hydrocarbons tend to be formed in high concentrations by slow moving traffic. Oxides of nitrogen are produced in greater quantities by traffic moving at higher speeds.

In the South Area, the most important source of these pollutants is traffic, both on local streets and on the portion of the Central Artery that traverses the area. Traffic volumes using local streets, particularly during off-peak hours, contribute a high percentage of existing carbon monoxide and hydrocarbons, because this traffic travels at slow speeds in stop-and-go conditions. The impact is felt directly by adjacent businesses, office buildings, and other developed areas. The Artery itself is located in tunnel for about 2500 feet or about 30 percent of its length through the South Area. The section in tunnel is ventilated by means of four stacks located in the vicinity of South Station; these act as point sources of automotive pollutants to the surrounding areas.

A measurement program designed to monitor background CO levels in the study area was undertaken as part of the 1975 South Station Urban Renewal Project Environmental Impact Report.[6] Two monitoring stations were selected--one located directly across Atlantic Avenue from South Station, and one located in the middle of the rail yards behind the South Postal Annex.

Figure 18: Measured CO Levels, (PPM) South Area

	1-hour	8-hour
National Ambient Air Quality Standard	35	9
South Station Site		
October	6.3	5.1
November	11.9	7.4
December	11.3	7.5
Rail Yards Site		
October	7.1	6.5
November	14.3	9.1
December	8.9	6.1

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6 "Air Quality Technical Support Document to the Environmental Impact Report--South Station Urban Renewal Project," ERT, Inc. May 1975.

Continuous measurements of CO concentration, wind speed, and wind direction were recorded over a three-month period (October-December 1974). Figure 18 presents the highest 1-hour and 8-hour CO concentrations recorded at the 2 sites in each of three months, and compares them with the National Ambient Air Quality Standards established for Carbon Monoixde.

The results of the measurement program suggest that the 1-hour CO standard is not likely to be exceeded unless conditions in the area change dramatically as a result of the proposed project. Such a radical change in traffic volumes or roadway configuration is not anticipated. The 8-hour standard was exceeded once during the measurement period, however, and is probably the critical standard to consider in analyzing air quality impacts of proposed South Area changes.

II.D.2 Noise

The noise climate along the South Section, as along the entire length of the Central Artery, is created primarily by the dense city traffic which traverses the area, both on the Artery itself and on local streets and arterials in the vicinity of the Artery. The expressway is already depressed and covered through about 1/3 the length of the South Section. Traffic flowing through this tunnel section is still audible to an observer standing near an entrance or exit ramp on the pavement above. It contributes to background noise level, but it does not represent a source of obvious, intrusive noise levels above the background at these locations. Nevertheless, peak noise levels in areas where the expressway is depressed tend to be as high as those where the road is at or above ground level. This is because the Artery is only one of a multitude of major noise sources, which taken together, create the background noise characteristic of such noisy urban situations that changes in the source strength (e.g., traffic volumes, speeds) or the geometric configuration (e.g., elevated, depressed of any one source tend to produce little variation in the overall noise level provided the other noise sources ramain unchanged.) In addition to traffic-generated noise, industrial activities associated with the nearby rail yards, the South Postal Annex operations and other activities in the Fort Point Channel area contribute substantially to relatively high areawide noise levels.

Where the expressway is visible in the South Area, it tends to be bordered by high-rise office buildings, industrial uses, or vacant or undeveloped land. During the daytime, especially during the morning and evening peaks, traffic on local streets and surface arterials is the predominant contributor to ambient noise at the first - and second-story levels of most buildings. This is because the local streets are much closer to observers on the first several floors than is the expressway. At higher levels of multi-story buildings abutting the unshielded right-of-way, the effect of the higher traffic volumes on the Artery becomes more important. At night, traffic on local streets tends to decrease, so that expressway traffic noise is dominant at all levels of adjacent buildings. The importance of this is mitigated by the fact that almost all nearby buildings are business or industrial locations, air conditioned during the daytime (i.e., having closed windows) and/or unoccupied at night.

In general, it can be said that existing noise levels in the South Area are quite high; however, they are not unusual or inappropriate for an urban industrial/commercial location. The surrounding land uses tend to be relatively insensitive to what might constitute severely annoying noise levels in a residential or suburban location. The only area potentialy sensitive to changes in noise climate resulting from modifications to the Artery in the South Area is the large Chinese residential community located west of the Artery, directly adjacent to the interchange with the Massachusetts Turnpike.

The numerical measurement of highway noise is done in terms of the dBA (decibel) scale, which measures sound intensities in such a manner as to weight frequency according to its magnitude relative to the varying thresholds of human perception. Empirically, the dBA scale has been found to correlate well with human response to typical traffic environments. To give an indication of how sound levels relate to dBA, 60-dBA is a normal indoor background sound level, 70-dBA is equivalent to a vacuum cleaner, and 80-dBA is about the sound level of a garbage disposal. It is important to note that the dBA scale is a logarithmic rather than a linear measure of sound intensity. Consequently, a 10-dBA sound level increase denotes a factor of ten higher intensity, while a 2- dBA increase denotes a factor of one-hundred.

The U.S. Department of Transportation, in its Policy and Procedures Memorandum 90-2, has established noise standards relating highways to specific adjacent land use activities. These standards specify that the design noise level for residential areas should not exceed 70 dBA outside the residences, and that the exterior noise levels for developed lands such as downtown areas, should not exceed 75-dBA. In the following discussion, noise is considered in terms of the dBA levels experienced 10% of the time, 50% of the time, and 90% of the time, respectively denoted as L10, L50, and L90.

Measurements of existing noise levels in the South Area Corridor were made as part of two recent studies: the 1975 Central Artery Feasibility Study undertaken by the Boston Redevelopment Authority, and the 1976 South Station Urban Renewal Project Environmental Impact Report. Figure 19 describes seven measurement sites located in the south Area, and presents the L10, L50, and L90 noise levels for those sites as reported in either of the two studies.

There are two noteworthy aspects of the measurement data. The first is that the consistently high L10 noise levels exceed the federal design noise standard for residential areas in all cases, and for developed areas in more than half. The second is that noise level fluctuations are relatively small. Only in one case is the difference between the reported L10 and L90 level greater than ten decibels. These findings demonstrate that a high "noise floor" or ambient noise level, exists throughout the South Area, created by a multitude of sources. Modifications to any single one of them including the Central Artery, will probably not produce significant overall changes.

Figure 19: MEASUREMENTS OF EXISTING NOISE LEVELS, 1975 and 1976

Location	Time of Day	Measured Noise Levels,dBA L10	L50	L90
1. Atlantic Ave., between Dewey Sq., & Essex St. *	8:00AM	74	70	66
2. Pedestrian walkway over Expwy. before tunnel ent. at Congress St. *	8:30AM	82	79	76
3. Congress St. over tunnel entrance between Atlantic Avenue & Purchase St. *	7:20AM	78	73	70
4. Bridge over Fort Point Channel on Congress St. *	7:20AM	72	66	62
5. Hotel Essex, facing Atlantic Ave.**	4-4:30PM	76	72	67
6. Kneeland St. & Atlantic Avenue **	10-12 AM	77	68	66
7. South Station -southern end of rail yard **	6-8:30AM	72	66	65

*Source: Memo from Klaus Kleinschmidt, Cambridge Acoustical Associates, to David Wallace, Wallace, Floyd, Ellenzweig, Moore Inc., re Central Artery Noise Survey, April 26, 1977.

**Source: "Noise Analysis Technical Support Document to the Environmental Impact Report--South Station Urban Renewal Project", prepared by Environmental Research & Technology Inc., May 1976.

II.D.3 Water Quality

The Central Artery South Section has an impact on water quality both as it exists today, and as it might be reconstructed in the future. At present, runoff from the Artery drains primarily into the Boston main drainage system, which is a very old combined sytem with interceptor sewers along the waterfront. These interceptors discharge into the MDC main drainage tunnel which in turn leads to the Deer Island treatment facility in Boston Harbor. Trunk sewers from the collection system discharge dry weather flows into these interceptors through regulators. Storm flows, however, pass directly into Fort Point Channel and the harbor through tide-gated outlet structures.

The City of Boston has proposed construction of increased capacity interceptor sewers, including a new Fort Point Channel Interceptor, to be located on the west side of the channel. A 1975 study recommended a decentralized overflow system including a Fort Point Channel facility that would connect all discharge locations.[7] As yet, none of the proposed facilities have reached the point of programming for implementation, nor have final designs for the facilities been drafted. As such, runoff from the Central Artery and other downtown streets will continue to discharge untreated into Fort Point Channel and Boston Harbor during storms for some time into the future.

Potential future Central Artery construction has further impacts related to water quality, because the split alignment option could have a highway tunnel built within the Fort Point Channel itself. Such construction would impact the bed of the channel which today is recognized as having among the most fouled conditions of any part of the Boston Harbor bottom. Previous studies have observed and sampled sludge deposits in the Fort Point Channel of more than three feed thickness, containing oily residues and emitting foul odors.[8] Oily muck completely paves the Fort Point Channel to a minimum depth of six inches. Absolutely no marine life is present. Measurements of water quality indicate that the surface water is grossly polluted as a result of storm water discharges and possibly by continuing dry weather flows as well.

With these problems, it is apparent that potential construction in the Fort Point Channel may offer an opportunity to remove polluted sediments. Obviously, such removal will have to be done with care taken

[7] Eastern Massachusetts Metropolitan Area Wastewater Engineering and Management Plan for Boston Harbor, prepared by Metcalf and Eddy for the U.S. Corps of Engineers and the Massachusetts District Commission, 1975.

[8] Biological Aspects of Water Quality-Charles River and Boston Harbor, Mass., performed by the Federal Water Pollution Control Administration of the U.S. Department of the Interior, 1967.

to ensure that undue further dispersal of old sediments does not take place. Combined with interceptor sewer construction, building of a highway facility in Fort Point Channel could offer the opportunity to markelly improve one of the worst pollution problems in the Boston Harbor area.

Figure 20: Boston Harbor Water Quality Survey
Station #39 - Fort Point Channel
(Mouth of Channel)

Sample No.	R54939	R55111	R55471	R55715	R55878
Date of collection	6/20/72	7/18/72	8/15/72	9/12/72	10/17/72
Time of collection	2:20pm	10:55am	11:40am	10:15am	10:25am
Temperature, deg F	-	-	-	-	56
Low Tide	1:15pm	11:37am	10:07am	8:47am	12:24pm
BOD	2.8	2.7	3.4	2.6	2.8
pH	7.8	7.6	7.7	7.7	7.7
Alkalinity-Total	84	108	102	107	103
DO	3.8	6.2	6.2	1.3	4.2
Chlorides	10,800	14,000	15,000	15,400	
Total solids	-	-	-	-	-
Susp. solids-Total	6.5	1.5	-	1.5	1.0
Loss	-	-	-	-	-
Total P	0.30	0.16	0.10	0.18	0.18
Coliform-Total	460,000	150,000	24,000	-	240,000
Fecal	460,000	93,000	2,400	-	93,000
Color	45	20	15	18	10
Turbidity	1	1	1	1	0
Total-Kj-N	2.2	1.0	-	-	-
Ammonia-N	0.38	0.5	0.31	0.26	0.38
Nitrite-N	-	-	-	-	-
Nitrate-N	0.1	0.0	0.0	0.0	0.0

Source: Commonwealth of Massachusetts, Division of Water Pollution Control, Metropolitan Regional Office, April, 1975.

CHAPTER III: ALTERNATIVES FOR IMPROVEMENT

During the past two decades, numerous plans have been proposed for improving the Artery. Some improvements have been implemented, but most of the plans have become documents for library shelves. Numerous studies for major improvements of related projects have also been undertaken, often without reference to the manner in which the Artery operates as part of a larger system of transportation service.

III.A PAST EFFORTS

Previous studies on the South Area of the Artery corridor have been numerous. They are summarized in Appendix I. The general trend of past studies has been to add facilities to the existing network, without altering the pattern of the present highway facilities. These studies have been summarized below in two groups-alternatives outside the present Artery corridor, and alternatives within the present corridor.

III.A.1 Alternatives outside the Artery Corridor

There have been several concepts for bypassing the Artery completely in order to avoid the difficult problems of serving both local and through traffic on the same facility. These have been dropped from further consideration for various reasons. The alternatives are as follows: (See Figure 21)

A. The Inner Belt
The philosophy of a radial expressway and inner belt highway system was presented in the Master Plan for Highways in the Boston Metropolitan Area in 1948, and was adopted by the Commonwealth as a basis for long-range improvement to area highways. The Central Artery was a portion of the Inner Belt under this plan.

The basic functions of the Inner Belt were: (a) to serve as a collector-distributor of traffic in the Core Area and (b) to interconnect radial expressways for traffic with an origin or destination either in metropolitan Boston or on any part of the interstate highway system.

As a partial result of this plan, the Central Artery was constructed. To complete the Belt, a series of 30 alternatives were studied and 10 were examined in detail. However, in 1971, Governor Sargent made the decision not to proceed with further plans for the Inner Belt, for these major reasons:

a. Extensive residential takings in Somerville and Cambridge and inability to meet the relocation requirements, which had become more stringent since initial plans were put forth.

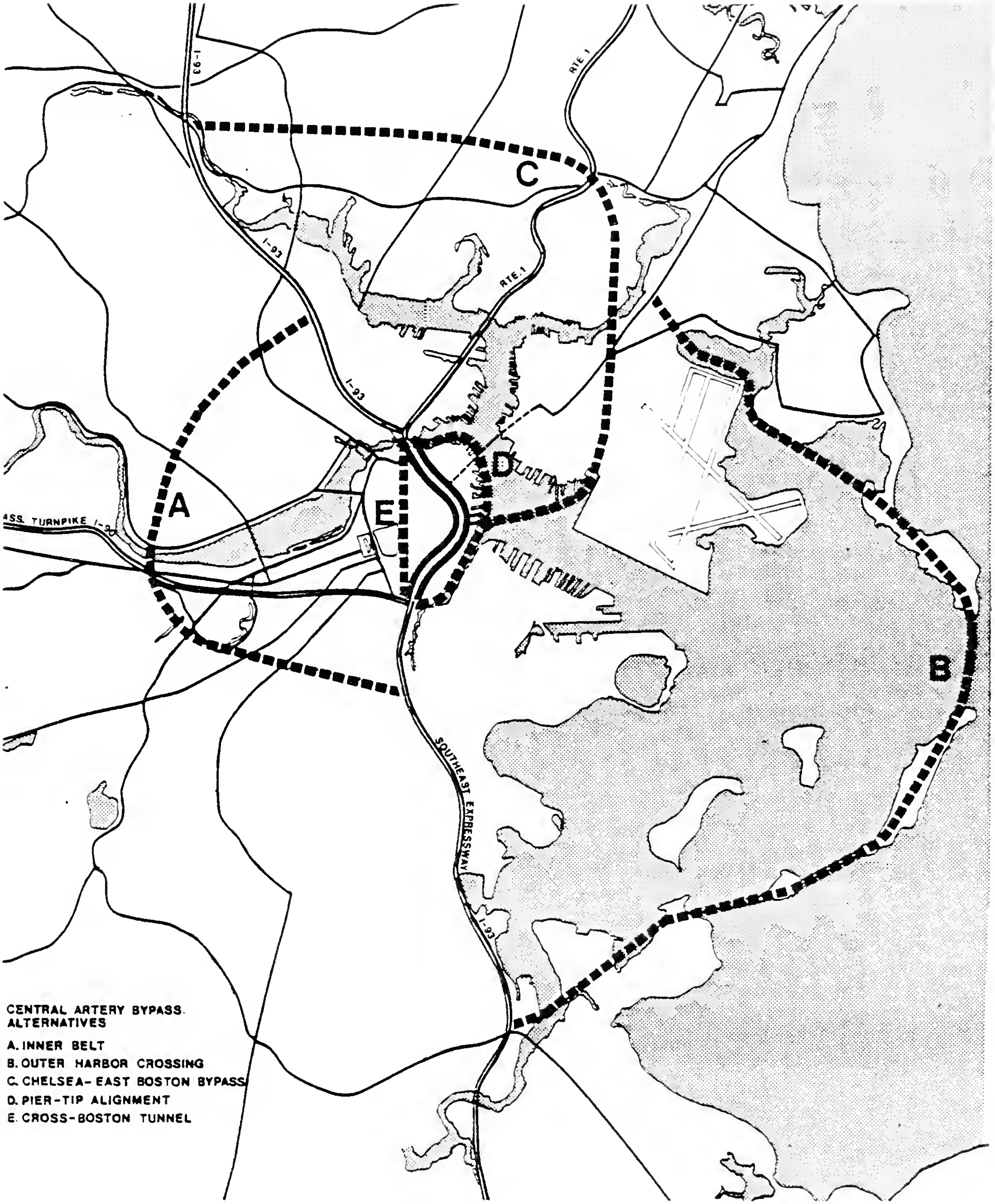
b. Major disruption to communities along the corridor of the proposed highway, to which local municipal officials had become opposed.

c. Community protest over the scale, location, impacts and costs of the proposed Inner Belt.

d. Technical questions resulting from re-examination of the traffic projections and the ability of connecting radials, including the Central Artery to accomodate projected volumes and movements.

e. Increased highway construction was considered to be counterproductive because it would generate traffic for the core area of Boston, which cannot accommodate present traffic and parking demands.

Since the Governor's decision, funds previously allocated to the Inner Belt have become part of the Massachusetts Interstate Transfer. In addition, the Commonwealth's transportation policy and decisions about specific facilities have reinforced the determination that the Inner Belt is no longer a feasible, desirable or prudent alternative, nor is it politically acceptable.



ALTERNATIVES TO THE ARTERY CORRIDOR

Figure 21

B. Outer Harbor Crossing

As early as the 1930's, a highway to connect between Route 1-A on the north and the area south of the core was examined. This was later reviewed and studied by the Boston Transportation Planning Review as a connection between Route 1-A and the Southeast Expressway. The proposed facility used the harbor islands for its route, through a combination of bridges and surface facilities. A major crossing of the shipping channel leading to and from Boston Harbor was included. While the alternative of a tunnel was suggested for this crossing, problems of interference with the shipping channel along with anticipated costs of construction precluded it from further consideration. The proposed bridge was similarly difficult; under-clearance requirements for shipping made the bridge height a hazard for Logan Airport flight path clearance standards. In addition the proposed approach roads would have violated Section 4(f) provisions in utilizing islands, wetlands and publicly owned land along the proposed alignment.

While this alternative would have provided connections for two major expressways and a bypass for the Central Artery, it did not provide connections and distribution to the various sections of the region, and it did not provide adequately for downtown collection and distribution. Access to the airport was also constrained by the need for interchange of traffic in either the residential or open space areas of East Boston. While it may well have resulted in new origins and destinations it did not address the problem of the existing traffic overloads on the Central Artery, as traffic was not diverted from the Artery.

C. Chelsea-East Boston Bypass

Another alternative investigated in 1971 was a downtown bypass from I-93 on the north, through Chelsea to East Boston and the airport and in a tunnel under the harbor, to connect to the Southeast Expressway-Mass Pike interchange at the south edge of downtown. This alternative was conceived as part of plans then being considered for I-95 north through Lynn, and I-95 relocated through East Boston and Revere. It was intended to address the problem of how traffic on the north from both I-93 and proposed I-95 could get access to the airport and around downtown for non-core destinations. The bypass was also directly related to a proposed general purpose third harbor crossing between East Boston and the Fort Point Channel area in South Boston, and in fact incorporated this tunnel as a major element of its alignment.

Early analysis of this alternative showed that the proposed alignment had a number of major problems of feasibility. The proposal would have required either a new alignment or a narrow rail right-of-way in the Everett/Chelsea area which would have caused substantial residential property takings and impacts on local neighborhoods. The Chelsea Creek crossing was complicated by the need to retain shipping access to the oil terminals located at the head of the creek. In East Boston, major conflicts with expressway and local circulation, along with substantial impacts on the adjacent residential community were also found. The location through either East Boston or the airport was another major problem. This was later resolved by a decision to use airport property for connections to the proposed third harbor crossing. Because of impacts of this alignment, longer tunnels were discussed, but the costs and potential impacts were prohibitive. In addition, because of the lack of direct connection to I-93, the over-capacity traffic conditions on the Central Artery would have remained.

After preliminary analysis and strong community objections to the alignment, this proposal was dropped. Its dependence on I-95 through Lynn, and relocated I-95 through East Boston and Revere became apparent, and both of these alternatives were dropped from further consideration by the Commonwealth. The third harbor crossing portion of the alignment remained as a viable portion of the proposed connection - not as a bypass of the Central Artery, but for service directly to and from the airport.

D. Pier-Tip Bypass

After analysis of alternatives outside the main core area of Boston, other alignments closer to downtown were investigated. A pier-tip bypass was proposed, connecting between the junction of the Mystic Bridge and I-93 on the north and the junction of the Mass. Pike and the Southeast Expressway on the south, and using the harbor bottom as the right-of-way along the ends of the downtown piers. The alternative's advantages were: (a) construction of a new facility without disturbing traffic in the heart of the city; (b) a right-of-way which would be "free" and which would afford relative ease of construction; (c) the potential for separation of local and through traffic with the existing Artery retained for the collection and distribution of traffic in downtown Boston.

However, this alternative did not address the problem of providing improved access between major expressways and the airport because it could not connect directly with the existing tunnels and the proposed third harbor crossing. This became a major deficiency, because the pier-tip tunnel would only serve north-south through traffic and not meet major demands for access between expressways and either the airport or downtown. Problems with the physical feasibility included grades of the connections on either end, possible interference with shipping in the harbor during construction, plus the logistical problems of constructing a long tunnel entirely under water, with attendant difficulties of getting approvals for the filling required to construct the tunnel.

Because of its prohibitive costs and environmental impacts, it was decided that the alternative was not feasible, and it was dropped from further study.

E. Cross-Boston Tunnel

The last of the alternatives that would bypass the corridor of the existing Central Artery was a proposal advanced in 1974 for construction of a deep-bore tunnel to connect directly from the Mystic Bridge I-93 intersection on the north to the Southeast Expressway and Mass. Pike interchange on the south. The elements of this proposal included an additional short tunnel connecting from the north to the entrance of the Sumner/Callahan Tunnels on an alignment directly under the existing Artery to serve airport traffic. It was proposed that, following construction, the Artery could be removed and the corridor used as a major arterial street providing access to downtown locations.

The advantages cited included: (a) the length of the tunnel, which would be the shortest possible connection between major regional expressways; (b) construction would not be entirely in the Artery corridor (other alternatives being considered at the time used the existing Artery corridor for a new facility); (c) preliminary examination indicated that overall construction impacts would be significant, but less than other alternatives.

The proposal had several major drawbacks: (a) its common weakness shared with other past proposals was its inability to deal with the role of the Central Artery as a downtown collector and distributor of traffic, though it did have the advantage of exclusive access to the Sumner/Callahan Tunnels; (b) the proposed arterial street could not adequately meet existing collection and distribution demands in the downtown area. It would have produced spillover traffic on local streets, with impacts on adjacent residential and business areas; (c) there are serious questions of feasibility that a highway rising from a deep-bore tunnel across downtown Boston could meet the necessary vertical clearance requirements to cross the Charles River without constructing a massive, multi-tiered interchange in the North Station area; (d) sub-surface conditions in the area of the proposed tunnel may be such that this alternative is technically infeasible. Construction problems near and under large buildings, utilities and subway tunnels were major. (e) the proposed tunnel would have required installation of extensive ventilation equipment to meet present and future air quality standards. The location of ventilation structures and the impact of the exhaust disposed through ventilation structures would have produced major negative impacts on downtown. For all of these reasons, this alternative was dropped from further study.

III.A.2 Corridor Retention

The analysis of alternatives to bypass the corridor of the present Central Artery has been instructive on several points:

1. Alternative alignments for the relocation of all or part of the present functions of the Artery cannot be easily found. Alternatives which have been presented and examined in some detail have the disadvantages of not replacing or relocating the functions of the Artery, and not substantially easing its present problems.
2. High costs are incurred in all of the alternatives to the present Artery corridor, both in terms of funding the construction and operations on adjacent neighborhoods.
3. The present Artery would have to be retained in virtually all instances as a collection and distribution facility for downtown, and in most instances for airport access via the Sumner/Callahan Tunnels as well.
4. Improvements to the present facility would be required in all alternatives. Safety considerations and the aging structure of the present facility must be dealt with at some future date. Simply eliminating the present Artery without adequately providing for its present functions is not a solution to transportation needs.

5. All of the alternatives to the present Artery tried to find means of avoiding the problems associated with construction of a new facility in the present Artery corridor while maintaining traffic. However, the present corridor of the Central Artery is the only alignment which affords all the advantages of connections between the radial regional expressway network. In addition, it is the only alignment which provides collection and distribution into the regionally important downtown area. It thus appears that the present Artery corridor must be retained for these functions.

6. Transit options cannot perform the functions provided by the Artery.

III.B ALTERNATIVES WITHIN THE PRESENT CORRIDOR

The South Area of the Artery Corridor contains highly valued land areas and neighborhoods which form major constraints on the selection of alternatives for improvement to the highways in the area. At the same time, these areas define the corridor locations in which opportunities are presented for highway improvements. Because of the efforts already underway to preserve and enhance several of these areas they have been listed below as the setting for further examination of alternatives.

III.B.1 South Area Highway Planning Context

Each of the efforts listed below is identified on Figure 22 by the numerical designation which appears in the text.

1. Waterfront Urban Renewal Project
The bulk of this project falls in the Central Area of the corridor, but several of the South Area improvements would affect development and parcels in the southerly portion of the project area. Specifically, this area includes the Harbor Towers apartment development and several waterside parcels not yet developed.

2. The Fan Pier - Athanas Properties

A large-scale private development on the Fan Pier and adjacent waterfront lands has been discussed; plans include apartment and marina activities.

3. Town and City Properties, Ltd.

Many of the existing structures - principally large warehouse structures - are planned for rehabilitation for new commercial uses. The redevelopment of the area is already in progress with some small-scale rehabilitation.

4. Railroad Properties

This land, recently offered for sale by the Penn Central Railroad Company, is largely vacant, with some residual railroad uses. Part of the area is scheduled for transportation improvements, including the re-aligned Northern Avenue approaches to a new Fort Point Channel bridge.

The right-of-way for the proposed Seaport Access Road would also potentially use portions of this land.

5. Gillette Company

A large manufacturing plant for the Gillette Company occupies a site on the Fort Point Channel. This plant is a chief location for the manufacturing of razor blades and associated products.

6. Cabot Yards

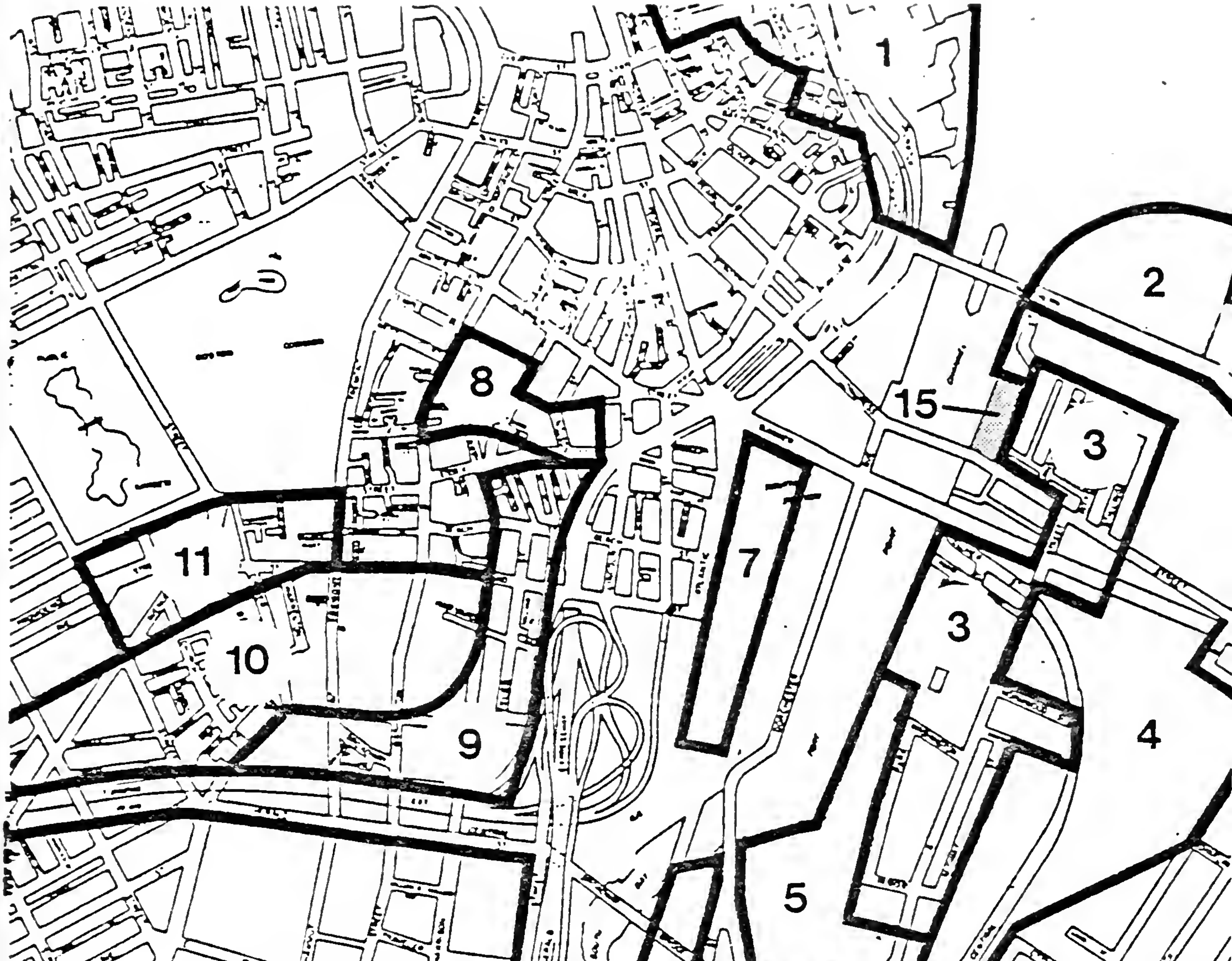
The MBTA has constructed a new facility for the maintenance and storage of its Red Line rapid transit vehicles on this site. The facility also includes a major bus storage and maintenance area.

7. South Station Transportation Center

Major plans for this site have been developed to construct a multi-modal transportation interchange facility, which will include intercity rail and bus, rail and bus commuter lines and parking.

8. Lafayette Place

This area has been designated for new commercial development, including expansion of the area occupied by the Jordan Marsh department Store, and additional commercial space to be



RELATED PLANNING EFFORTS

Figure 22

constructed adjacent. Street changes include a new Essex Street which will connect directly with the Artery corridor.

9. Chinatown
The long-established Chinese community is based in this area. Shops, apartments and cultural facilities continue this focus. A new school and new apartments have strengthened the community in recent years.

10. South Cove Urban Renewal Area
This project has provided space for the expansion of the Tufts-New England Medical Center and includes the small community known as Bay Village.

11. Park Plaza
Recent city efforts have led to a plan for a multiple use area which will include retail activities, government and private offices and apartment units.

12. South End Urban Renewal Area
This large neighborhood has been the location of major urban renewal efforts over the past years. Many of these efforts have been directed toward strengthening the residential character of the area. Both public and private efforts have resulted in the restoration of structures and the enhancement of the community.

13. South Bay
This area is the location of a new maintenance facility constructed by the City of Boston, and is the site of the Wholesale Food Market. Residual railroad facilities are also found here.

14. South Boston
This area is a stable residential community which contains manufacturing and shipping concerns. Truck traffic on residential streets is being addressed through planning of the Seaport Access Road.

15. Museum Wharf
This location is the new home of the Children's Museum and the Museum of Transportation. A former wharf

building, it will be rehabilitated for museum use and will be partially opened in the fall of 1978.

III.B.2 Derivation of Alternatives

Land uses and proposed community improvements were examined in conjunction with transportation problems in the South Area of the Central Artery. Constraints imposed by the need to plan improvements within the existing corridor and to minimize impacts on surrounding areas led to two classes of alternatives. The first group provides for improvements along the present alignment. This includes the no-build option, widening of the present Dewey Square Tunnel and double-decking. In all cases, traffic in both directions would continue to use the present alignment with proposed modifications.

The second class of alternatives would split the alignment in the Dewey Square portion of the corridor, with southbound traffic using the present Dewey Square Tunnel and northbound traffic using a new alignment in one of two possible locations: under either Atlantic Avenue or the Fort Point Channel. In order to narrow alternatives, each of these groups were analyzed in some detail.

III.B.2.a Improvements along the Present Alignment

This set of improvement options centers on the existing Dewey Square Tunnel.

1. No Build -
In this option the existing facility is retained and modified as necessary to accomodate minor improvements for traffic service and safety. Traffic capacity and design standards would remain the same as they now are. Deck rebuilding would be required south of the Dewey Square Tunnel because the decks are approaching the end of their useful life.

2. Widening of the Dewey Square Tunnel -
Several possibilities exist for widening, and range from modest improvements to breakdown and speed change lanes to the addition

of new lanes for carrying traffic. If new lanes are added, they must be located outside the existing tunnel on one or both sides, with traffic reallocated between existing and new facilities. South of the Dewey Square Tunnel, the viaduct would consist of 3 lanes in each direction, with shoulders used in peak periods to accommodate traffic demand.

3. Double Decking the Present Facility - This option would create an additional level of highway on a viaduct over the surface street which is now above the Dewey Square Tunnel. Capacity of the South Area would be increased and the tunnel would no longer act as a bottleneck for traffic because it would only carry southbound traffic and the new viaduct only northbound traffic.

Each of these options for improvements along the present alignment has been examined for feasibility and adaptability to the Artery setting. The No Build option must be carried forward, not only because it may in fact be a reasonable solution, but also because it provides the base case for analysis of other options. Widening also can be retained, as a possible cost saving approach to solving certain of the Dewey Square Tunnel problems. However, preliminary analysis indicates that impacts from widening of the present facility are severe for adjacent communities and would be unacceptable to them. Selective widening of modest proportions can be examined for specific locations where operational problems can be solved by modifications to speed change lanes or by adding breakdown bays. Such improvements would be part of the No Build option.

Double decking would be unacceptable to the communities nearby and would extend the blighting influence of the existing viaducts into the Dewey Square area. The design of links between the new upper deck and the existing facilities would also be difficult to achieve without substantial environmental impacts and would disrupt traffic during the construction period. For these reasons, double decking has been dropped from further consideration.

III.B.2.b Split Alignment Alternatives

This set of improvement possibilities centers on the use of both an improved Dewey Square Tunnel for southbound traffic and a new facility parallel to the tunnel for northbound traffic. This new facility could be located in one of two locations - either the Fort Point Channel or Atlantic Avenue.

1. Fort Point Channel Split Alignment

This option would have a new northbound tunnel in the Fort Point Channel - parallel to the existing Dewey Square Tunnel which would serve southbound traffic. The new tunnel would begin at the Turnpike interchange and extend in the Channel to join the existing Central Artery right-of-way in the vicinity of the Northern Avenue Bridge. By adding new capacity, this option would relieve the present constraint formed by the Dewey Square Tunnel. Design geometrics of both the Dewey Square Tunnel and the new roadway would be improved to meet acceptable standards. This right-of-way affords ease of construction because of a relatively clear alignment, without major traffic disruption and physical restraints imposed by existing development.

2. Atlantic Avenue Split Alignment

This option is similar to the Fort Point Channel alignment except the new northbound tunnel would be located under Atlantic Avenue. The new tunnel would extend from the existing right-of-way at the Turnpike interchange under the rail yard and Atlantic Avenue and rejoin the present Artery near Dewey Square. Benefits in terms of geometrics and capacity improvements are similar to the Fort Point Channel alignment.

This option is more difficult to construct because it must pass under commuter rail and AMTRAK lines and a heavily travelled street, and above an existing rapid transit station at South Station. It also must pass through a narrow right-of-way at Dewey Square. The constrained right-of-way makes it extremely difficult, if not impossible, to add a transit connection between North and South Stations as part of Central Area reconstruction plans, should it be undertaken. Nevertheless, the option has been retained for more detailed examination. For purpose of this discussion, the Atlantic Avenue alignment is included as a variation of the Fort Point Channel Split Alignment.

III.C ALTERNATIVES FOR FURTHER STUDY

Based on the previous studies in this part of the metropolitan area and the constraints which limit alternatives for South Area highway improvements, several new alternatives have been identified within the context of other proposed highway improvements. These have assisted in formulating potential improvements for the South Area.

III.C.1 Relationship to other potential projects

In the densely built-up core area, it is difficult to find rights-of-way for new highways to improve the regional network. It is the Commonwealth's policy to expand the transit network for core-oriented trips and to improve highway service for trips that cannot be served by transit. While the transit network can be expanded to improve the regional population's access into the core of the region, it cannot be expected to displace the need for maintaining adequate highway service to and through the core.

The potential projects which influence decisions in the South Area of the Artery Corridor are:

1. The proposed improvements in the Central Area of the Artery Corridor.
2. The proposed third harbor tunnel between downtown and Logan Airport. If constructed, this project would connect only to Logan Airport. It has two possible forms of service:
   a. A special purpose tunnel, serving only buses, trucks, taxis and emergency vehicles to and from the airport.
   b. A general purpose tunnel serving all types of vehicles to and from the airport.
3. The proposed rail connection between North Station and South Station. This proposal is applicable only to the alternatives which link to the Central Area of the Artery corridor.

III.C.2 Separability of the South Area

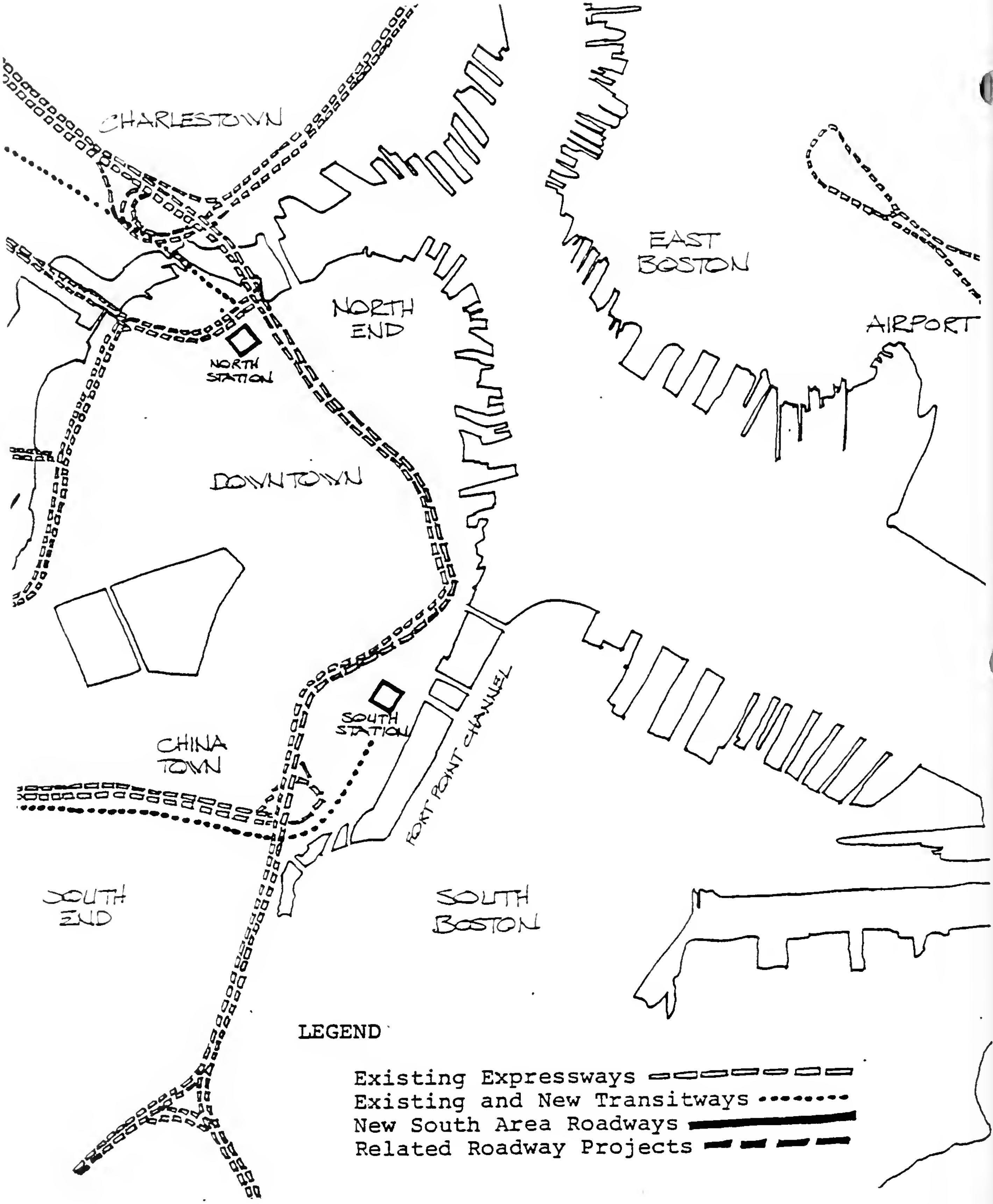
Proposed improvements in the South Area can take place either in conjunction with other improvements or as separate projects. For purposes of analysis, the South Area has been examined as a single project - for both no-build and build alternatives - and in conjunction with other related projects. This has produced several permutations of potential improvements which are outlined in Figure 23.

Figure 23 South Area Alternatives

	Without 3rd H.C.	With 3rd Harbor Crossing	
		Special Purpose	General Purpose
NO BUILD	Alt. 1	Alt. 2	Alt. 3
SPLIT ALIGNMENT WITHOUT CENTRAL AREA	Alt. 4	Alt. 5	Alt. 6
SPLIT ALIGNMENT WITH CENTRAL AREA	Alt. 7	Alt. 8	Alt. 9

III.C.3 Feasible Alternatives

Each of the alternatives included in the chart above has been examined in detail to determine system and traffic operations characteristics and the potential impacts which might result from implementation. The alternatives, each of which is discussed below, are followed by a brief discussion of the feasibility of construction of a northbound tunnel for split alignment configurations. For Alternatives 4-9, it has been assumed for technical analysis purposes only, that the split alignment with a new northbound tunnel will have three lanes with a shoulder used in peak periods to accommodate traffic demand. Modifications will be made to the existing Dewey Square Tunnel to allow for the same configuration.



ALTERNATIVE 1: NO BUILD

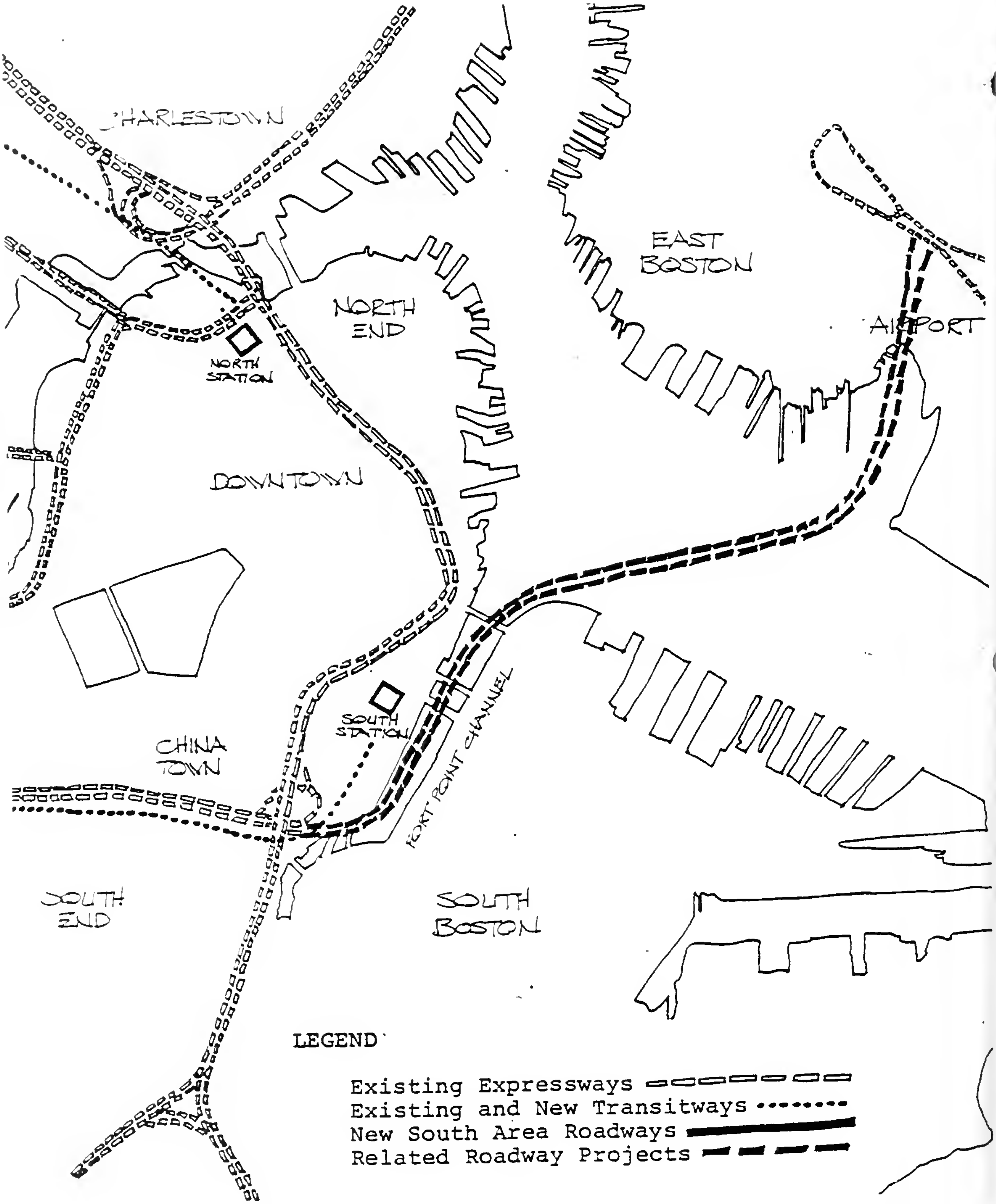
Figure 24

III.C.3.a Alternative 1 - The No Build Alternative

The No Build Alternative has been developed to explore the possibility of retaining the existing facility, with some modifications, in order to maximize its economic life. The viaduct in the South Area needs replacement of the decks within the immediate future if no other improvements are made. Within the past few years the Department has undertaken stop-gap maintenance measures to repair certain sections of these decks. Unlike the central section of the Artery, these decks were designed and constructed without protective bituminous concrete wearing surface. As a result, the age of the decks coupled with increasing wheel loads and salting action during the winter months, has contributed to the deteriorating condition of the decks. One possible method of undertaking this work is as follows:

> Rebuilding of one lane of the decks at a time. This method is a standard technique when traffic must be maintained. It has the obvious disadvantage of reducing capacity on a roadway and in this case reducing it by at least one-third. However, during previous maintenance operations, replacement capacity was found on the parallel frontage roads along both sides of the viaduct, i.e., Albany Street on the western side and Frontage Road on the eastern side. If full reconstruction of the viaduct were undertaken, these parallel roadways could be used during the construction period to act as a queue bypass.

Selective widening of the Dewey Square Tunnel for the purposes of providing speed change lanes or breakdown bays in key locations can also be undertaken as part of the no-build alternative. Subsequent analysis of these possibilities will indicate how useful they might be in improving safety and operations of the tunnel. No-build improvements do not offer a long-term solution to the problems of the South Area. Congestion, delay and accidents can be expected to continue at the present level and to worsen over time. Contiguous land areas will still be subjected to traffic spillover with its associated environmental problems.



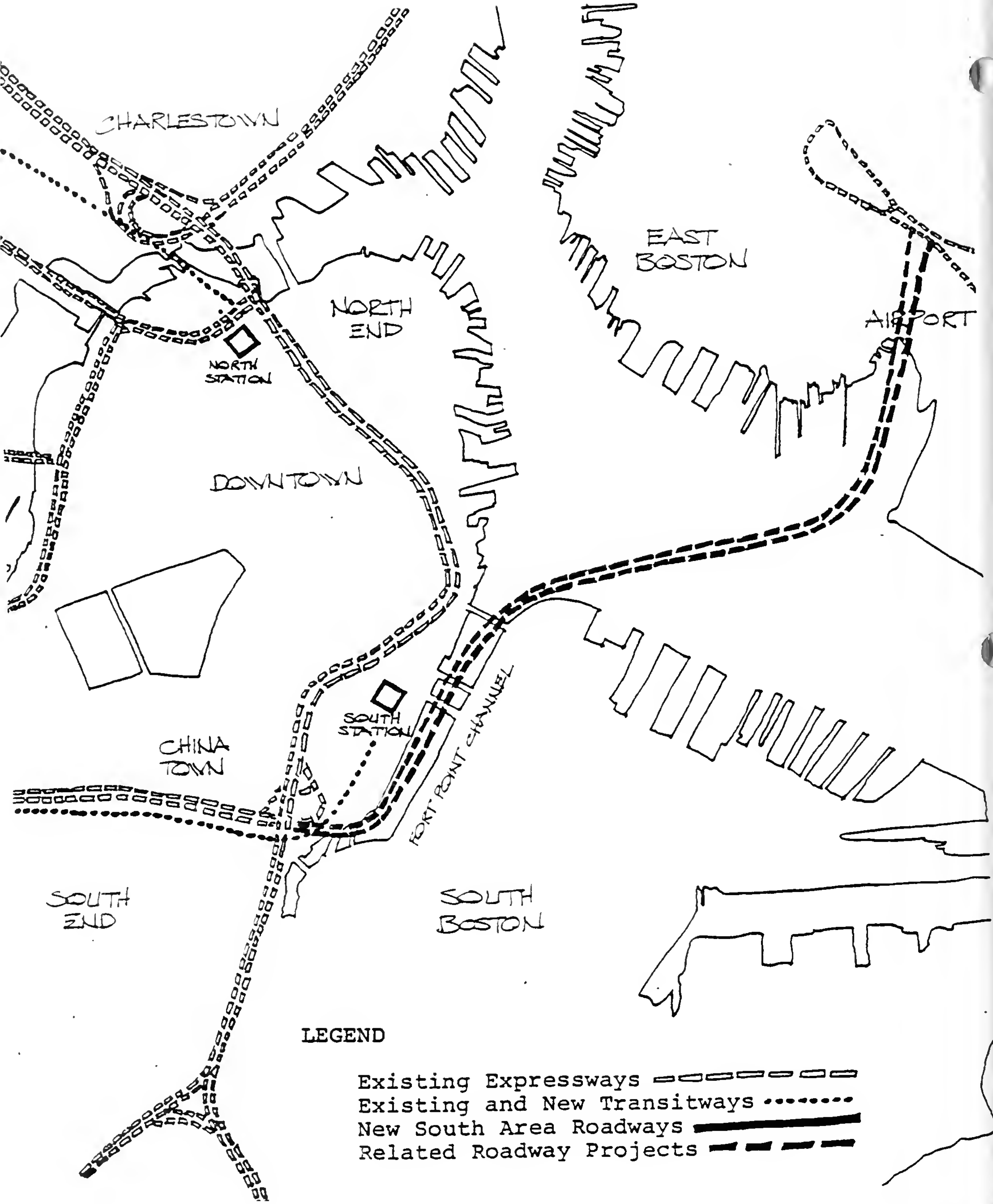
ALTERNATIVE 2: NO BUILD
WITH SPECIAL PURPOSE HARBOR TUNNEL

Figure 25

III.C.3.b Alternative 2 - The No Build Alternative with a Special-Purpose Third Harbor Tunnel

Alternative 2 is similar to Alternative 1 in all respects, except for a special purpose third harbor tunnel. The connection between the South Area expressway facilities and the proposed tunnel would be made at the interchange between the Central Artery and the Turnpike. The two-way special purpose tunnel would be located by itself in the Fort Point Channel.

This alternative has no South Area Artery improvements, and would have serious disadvantages for the overall improvement of the Artery and upgrading its safety and efficiency. It would foreclose any major future improvements to the South Area of the Artery and continue the existing substandard operational and safety conditions in the Dewey Square Tunnel. While it would provide improved service to limited types of vehicles, it would primarily serve only those vehicles approaching from the West and South. From other directions such vehicles would have to travel the full length of the Artery to reach the tunnel approaches. It would have the salutory effect of removing vehicles from the Central Area of the corridor, to the extent that the service provided by buses or other multiple-occupancy vehicles could attract more ridership.



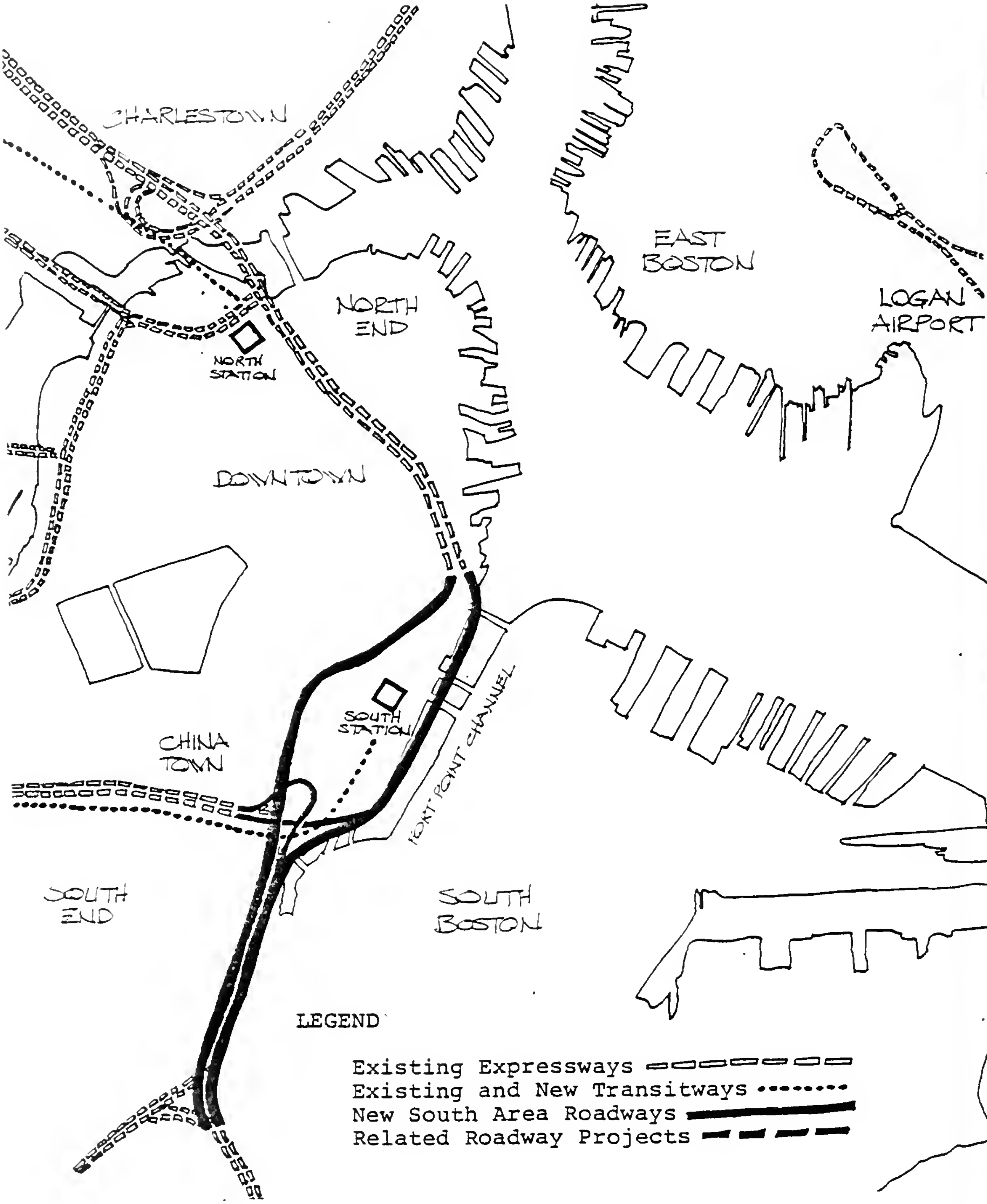
ALTERNATIVE 3: NO BUILD
WITH GENERAL PURPOSE HARBOR TUNNEL

Figure 26

III.C.3.c Alternative 3 - The No Build Alternative with a General-Purpose Third Harbor Tunnel

This alternative is similar to Alternative 1 in all respects, except for a general purpose third harbor tunnel. The connection between the South Area expressway facilities and the proposed tunnel would be made at the interchange between the Central Artery and the Turnpike. The two-way general purpose tunnel would be located by itself in the Fort Point Channel. There would be no changes in the existing Dewey Square Tunnel, because the new tunnel would operate independently of the Artery and connecting roadways.

This alternative has no South Area Artery improvements, and would have serious disadvantages for the overall improvement of the Artery and upgrading its safety and efficiency. It would foreclose any major future improvements to the South Area of the Artery and continue the existing substandard operational and safety conditions in the Dewey Square Tunnel. While it would provide improved service to the Airport, it would primarily serve only those vehicles approaching from the West and South. From other directions such vehicles would have to travel the full length of the Artery to reach the new tunnel. The physical connections of the new tunnel to the Artery at the existing interchange near Kneeland Street is more complicated than other alternatives. By providing for two-way traffic between all expressways (and potentially to South Station as well) the ramps in the interchange must be substantially revised both in alignment and profile to meet the new tunnel.



ALTERNATIVE 4: SPLIT ALIGNMENT
WITH NO OTHER MAJOR IMPROVEMENTS

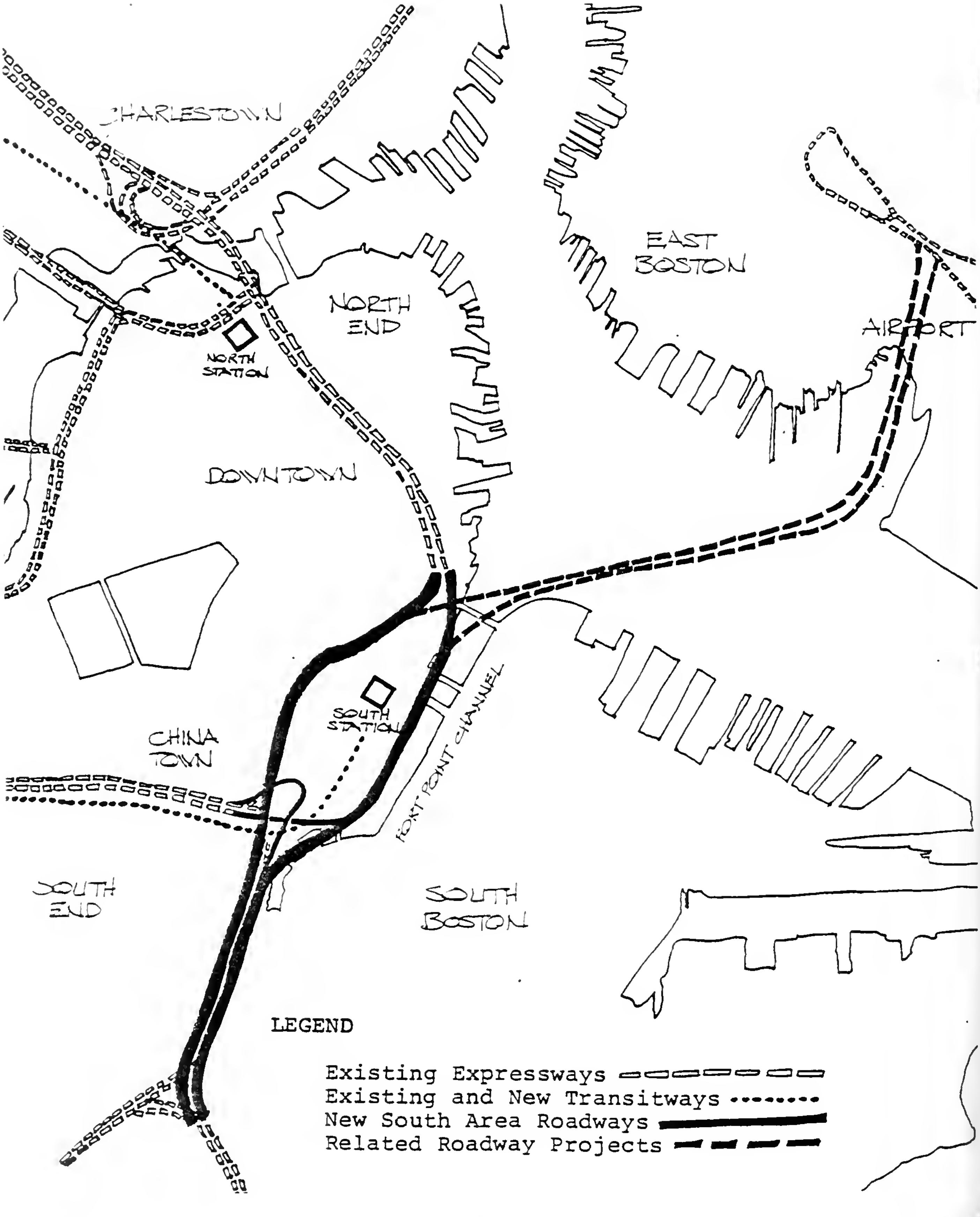
Figure 27

III.C.3.d Alternative 4 - Split Alignment with no other major improvements

In this alternative, the South Area of the Artery is reconstructed but no major improvements are made to the central section. The reconstruction of the South Area would include splitting the alignments, with the new I-93 northbound tunnel located in the Fort Point Channel or under Atlantic Avenue. It would be connected to the elevated central section in the vicinity of Northern Avenue. The Dewey Square Tunnel would be retained for southbound movement, with modification of the existing tunnel and ramps to accomodate the split of north-& southbound movement. At least 3 lanes with a shoulder used in peak periods to accommodate traffic demand will be provided in both tunnels. Local street connections would be modified to improve service between the expressways and the surface streets. Additional ramps could be provided at a later date to connect to the third harbor tunnel, if that facility is to be constructed.

Additional capacity in the Dewey Square Tunnel would provide traffic relief for the South Area. New connections to the local street network would improve access to and from the South Boston/seaport areas, South Station and the proposed transportation terminal, and the retail and financial districts of downtown Boston. Since these improvements connect directly with the Central Area of the Artery, the Massachusetts Turnpike, and the Southeast Expressway, each of the facilities would also benefit from improved traffic service in the South Area.

This alternative is not contingent upon the Central Area Artery improvements, and thus would require a distinctive treatment of the link between the northbound tunnel and the existing elevated Artery structure near Northern Avenue.



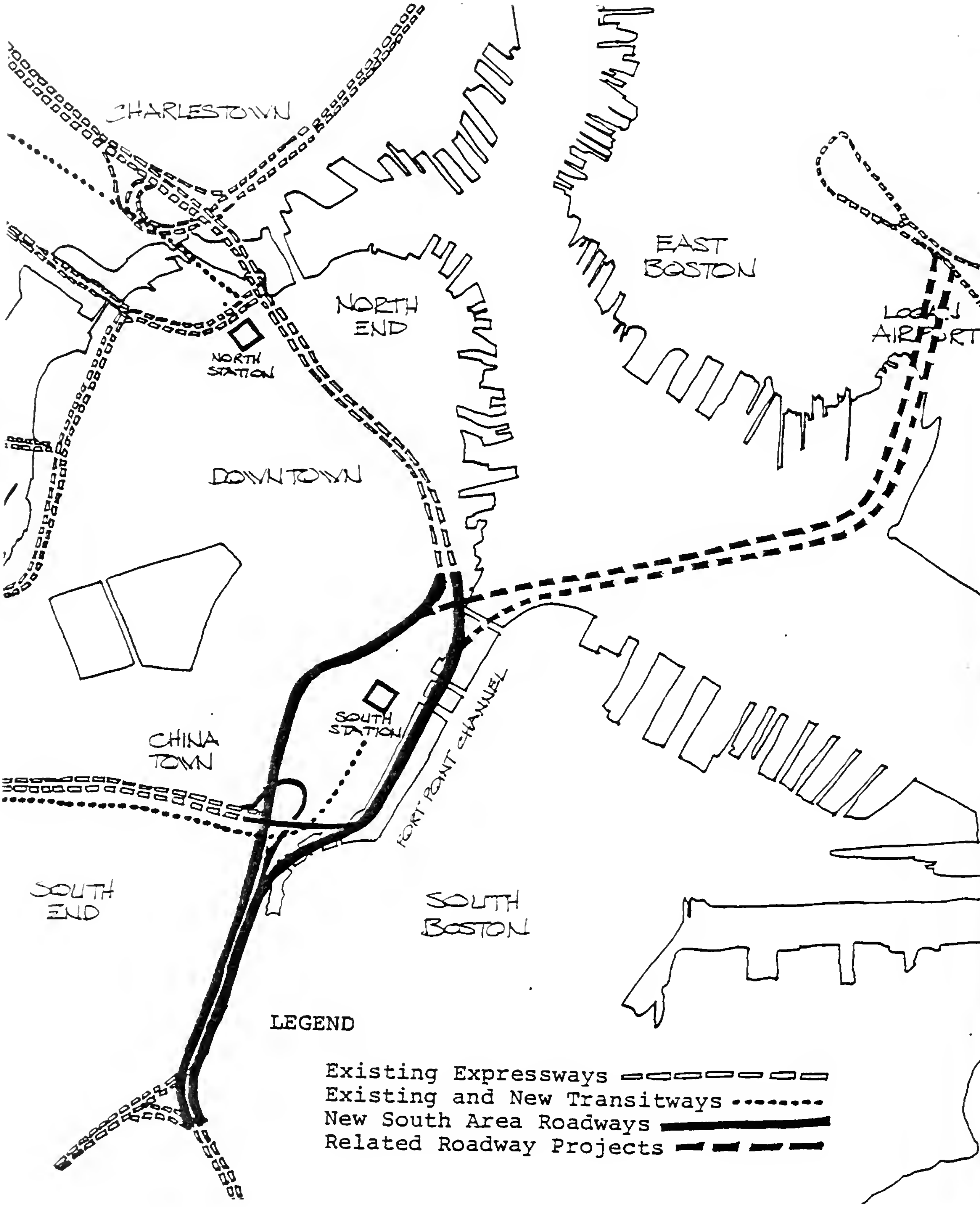
ALTERNATIVE 5: SPLIT ALIGNMENT WITH SPECIAL PURPOSE HARBOR TUNNEL

Figure 28

III.C.3.e Alternative 5 - Split alignment without the Central Area Project and with a Special Purpose Third Harbor Tunnel

This alternative is similar to Alternative 4 with the addition of the special-purpose tunnel to and from the airport. Connection to and from the harbor tunnel would be made to both the new northbound roadway and the existing Dewey Square Tunnel.

This alternative would allow construction of the northbound roadway and the special-purpose tunnel to be undertaken without disruption to existing traffic. However, connections between the new northbound tunnel and existing roadways could not be made without some traffic disruption during the construction period.

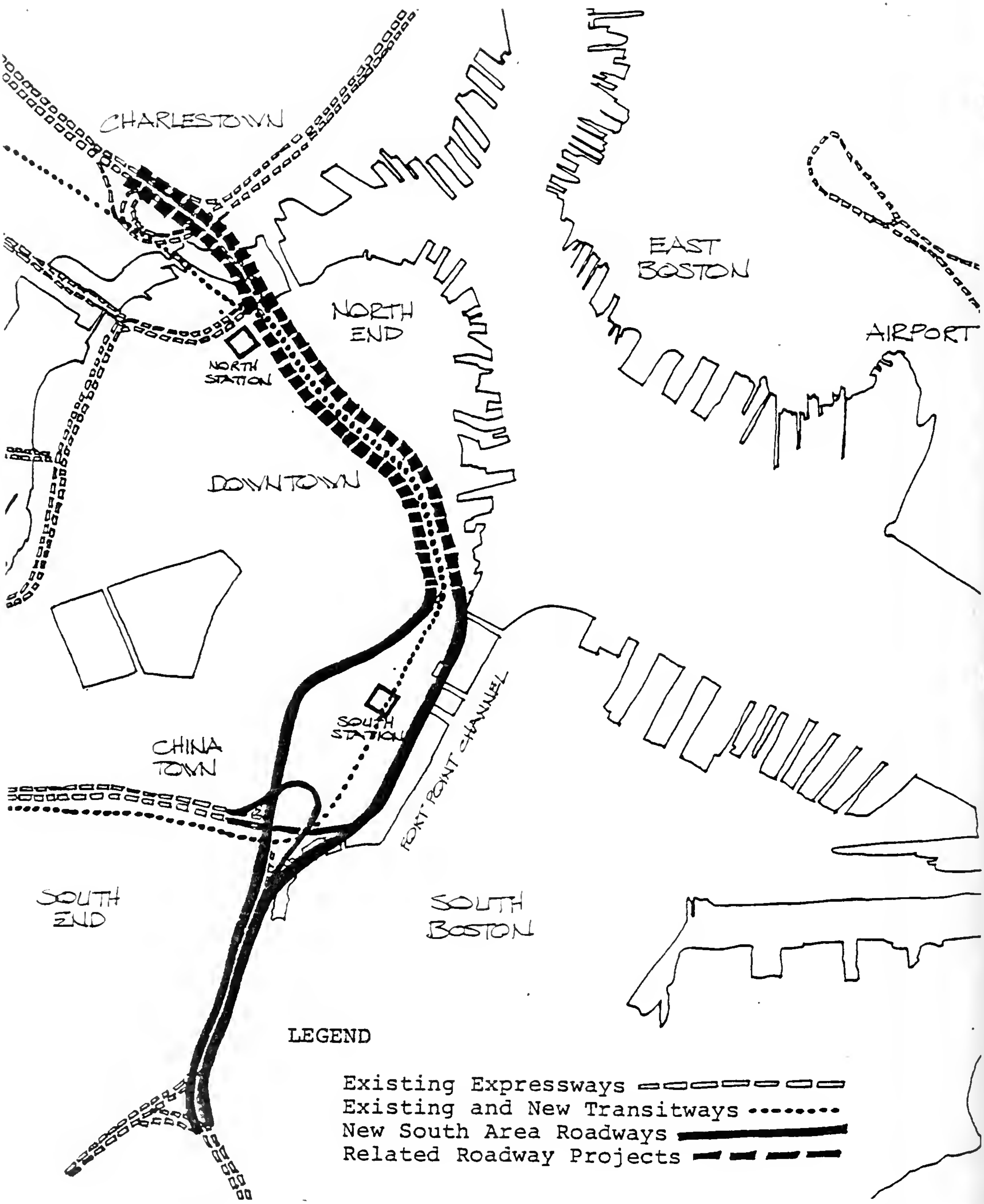


ALTERNATIVE 6: SPLIT ALIGNMENT
WITH GENERAL PURPOSE HARBOR TUNNEL

Figure 29

III.C.3.f Alternative 6 - Split Alignment without the Central Area Project and with a General-Purpose Third Harbor Tunnel

This alternative is the same as Alternative 5 with the exception of general purpose traffic utilizing the proposed harbor tunnel.



ALTERNATIVE 7: SPLIT ALIGNMENT
WITH CENTRAL AREA RECONSTRUCTION

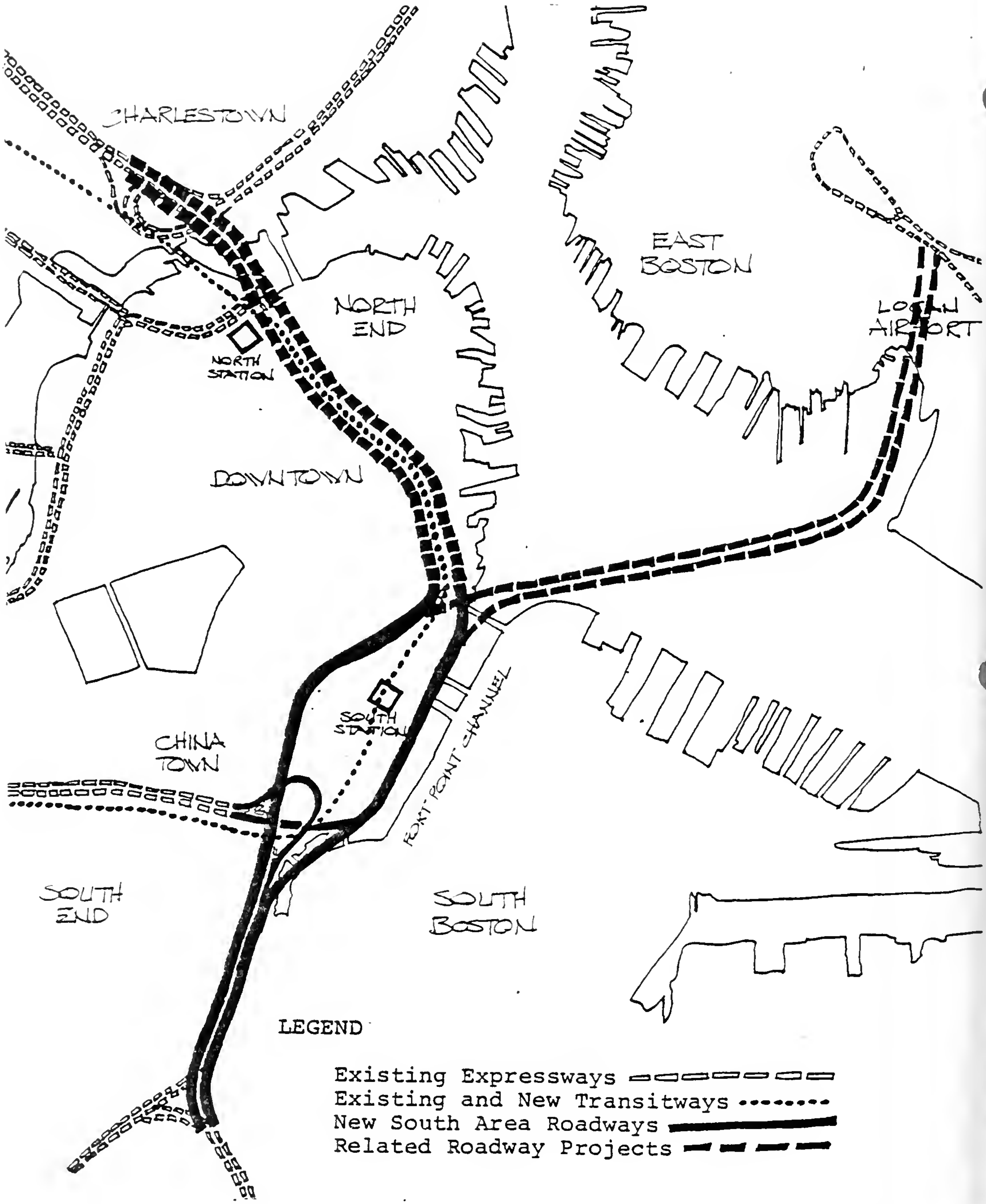
Figure 30

III.C.3.g Alternative 7 - Split Alignment with the Central Area Project

As in Alternatives 4-6, this alternative provides for a major improvement in the South Area with the construction of a new northbound roadway parallel to the Dewey Square Tunnel. The existing Dewey Square Tunnel would then become one-way southbound. Both the relocated northbound roadway and the improved southbound roadway would link to a rebuilt Central Area of the Artery. The connection, located near the Northern Avenue Bridge, would be underground. Additional connections could be provided at a later date to the proposed third harbor tunnel if that facility is to be constructed.

While no definitive construction staging has yet been developed, it is anticipated that the sequencing might proceed by first constructing the new northbound roadway tunnel. Northbound traffic could then be shifted from the existing roadway to the new tunnel alignment. Southbound traffic, north of the Dewey Square Tunnel, could be shifted to the northbound roadway in the tunnel while modifications are made to southbound tunnel tube and connections made to the central section. The time to complete this work is estimated to be three years, depending on the linkage to the central section of the Artery.

The proposed North Station-South Station rail connection, which is part of the Central Area project, is not a part of any alternative for the South Area, except immediately behind South Station. At that location, any future direct access roads into the proposed South Station Transportation Terminal would have to cross the alignment of the proposed underground rail connection.



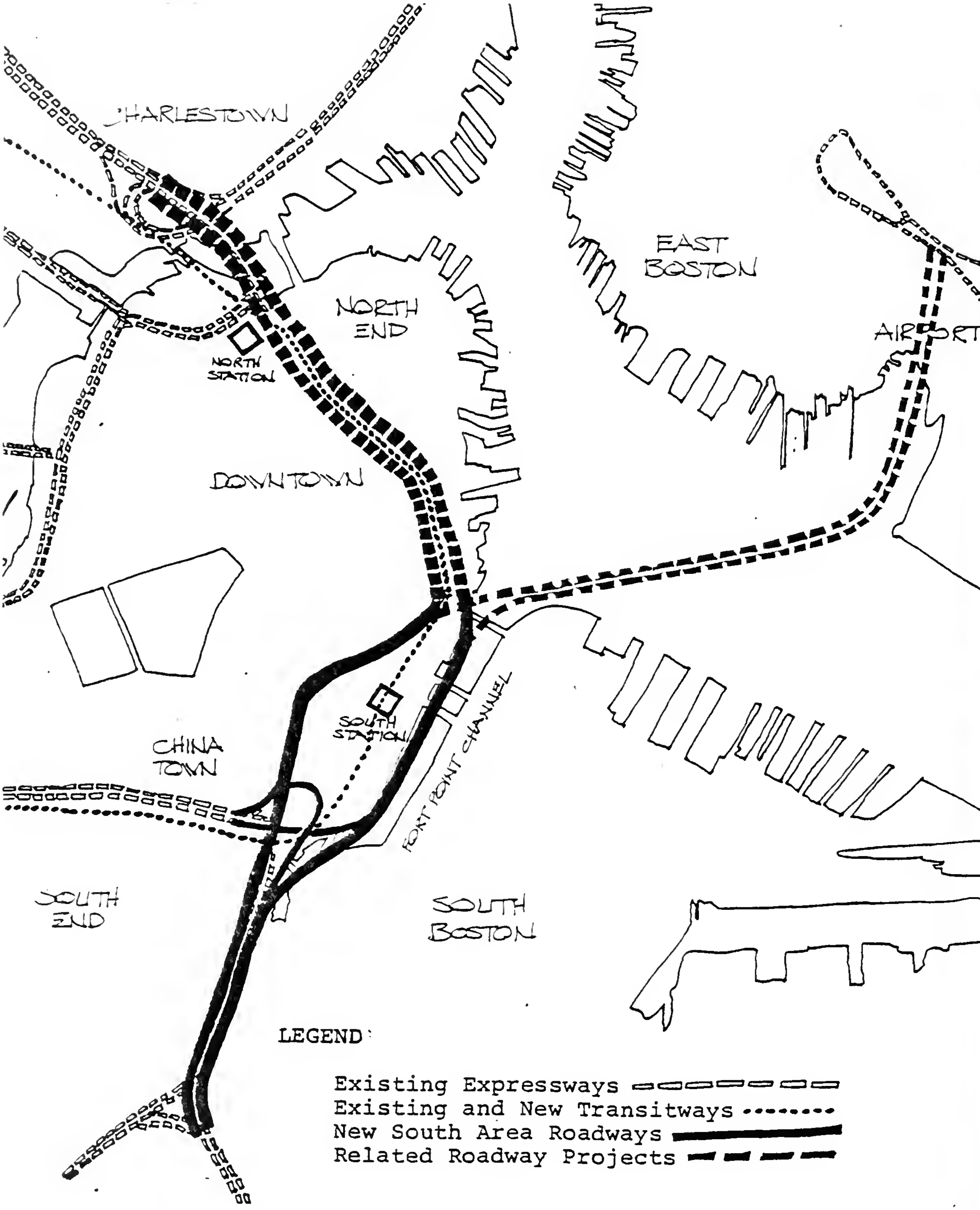
ALTERNATIVE 8: SPLIT ALIGNMENT
WITH SPECIAL PURPOSE HARBOR TUNNEL AND CENTRAL AREA RECONSTRUCTION

Figure 31

III.C.3.h Alternative 8 - Split Alignment with the Central Area Project and a Special Purpose Third Harbor Tunnel

Alternative 8 is similar to Alternative 7 and includes a special-purpose third harbor tunnel to and from the airport. The tunnel would connect with the South Area project in the vicinity of Northern Avenue, and would link to the new northbound roadway and the existing Dewey Square Tunnel. Local street connections would be provided as in Alternative 7.

As in Alternative 7, construction of the northbound roadway and the special-purpose tunnel could be undertaken without disruption to existing traffic. Construction phasing of this alternative would be closely integrated with the phasing of the Central Area improvements.



ALTERNATIVE 9: SPLIT ALIGNMENT

WITH GENERAL PURPOSE HARBOR TUNNEL AND CENTRAL AREA RECONSTRUCTION

Figure 32

III.C.3.i Alternative 9 - Split Alignment with the Central Area Project and a General Purpose Third Harbor Tunnel

Alternative 9 is the same as Alternative 8 except that the third harbor tunnel is a general-purpose facility to and from the airport. The tunnel would connect with the South Project in the vicinity of Northern Avenue and lead to the airport access road. Direct connections between the third harbor tunnel and the North Shore would not be provided in this option. There would be direct connections for traffic between the Southeast Expressway and the Massachusetts Turnpike and the harbor tunnel. Access from the north and northwest to the harbor tunnel would be less direct; this traffic would continue to use the present harbor tunnels for access to and from the airport.

III.C.4 Construction Feasibility

Preliminary plans for the South Area include several alternatives which have been investigated in some detail to determine their feasibility. Those alternatives which rebuild the existing facilities have ample and substantial precedents for feasibility. Replacing of decks has been undertaken on several roadways in the Commonwealth, thus giving precedent on technique for sequencing of construction and undertaking the demolition of existing decking and replacing it with new surfaces.

Those alternatives which call for a new tunnel in the Fort Port Channel have significant distinctions from previous projects to warrant special mention. The preliminary plans call for a subaquaeous tunnel in the Channel to carry northbound traffic. Major problems confronting construction of this tunnel include the proximity of the South Postal Annex, the Stone and Webster Building, the bulkhead supporting Dorchester Avenue, the Channel bridges at Summer and Congress Streets and at Northern Avenue, and the Red Line MBTA tunnels. The transit tunnels are located in mid-channel and are parallel to the proposed northbound Artery tunnel for approximately 2800 feet before turning to pass inland under Summer Street. The transit tunnels were built over 50 years ago and are very sensitive to any changes in the existing balance of sub-surface pressures. Subsurface conditions in the channel indicate the presence of soft compressible and unstable soils overlying clay and glacial till. The design of the Artery tunnel must safeguard the existing Red Line tunnels against imposition of either vertical or lateral loads, both during and after completion of construction.

Preliminary design alternatives have been developed for the Fort Point Channel tunnel. They include a sunken tube, cut-and-cover and mined tunnel designs. If built within the Channel (as opposed to under the right-of-way of Dorchester Avenue) the most appropriate design may be a sunken tube. However, the problems of constructing the tunnel so close to the Red Line tubes may dictate construction of the tunnel within the confines of a diaphragm sheet pile cofferdam, or concrete slurry wall consisting of continuous bored, cast-in-place concrete piles.

If construction of sunken tube technique is to be utilized, the tunnel sections are constructed off-site and floated into place as needed. Preparation work for the floor to support the tubes is, however, complicated by the presence of the Red Line tunnels. One method which has been investigated is the preparation of the site for each section of tube by installation of a series of underground pile bents. This work is succeeded by the construction of a cofferdam, which allows dewatering of the site, and construction of concrete pile caps to sustain the tubes. When completed, one end of the cofferdam is removed and the prefabricated tubes are floated into place and installed. The entire cofferdam is then removed and surfaces are then prepared for landscaping or other uses.

Alternatively, it is also feasible to construct the tunnel within the confines of a continuous diaphragm wall to serve as a cofferdam. By making the cofferdam wide enough to accomodate the width of proposed construction, it would provide a construction area within which a concrete structure could be constructed in the dry. When completed, the construction cofferdam wall may be retained to serve as a permanent structural wall. At the location where the tunnel must cross the Red Line tunnel (as it turns to go under Summer Street), prestressed-precast tunnel sections would bridge the area without imposing any load on the Red Line tunnels. The foundation support for this bridge type section could consist of either bearing directly on the granular soils as a spread footing, or of pile or caissons founded in glacial till.

Construction inland from the Fort Point Channel is based on more conventional techniques. The option of a new northbound tunnel under Atlantic Avenue would be constructed in that vicinity by the cut and cover technique. Direct connections to Northbound tunnel would require a driven tunnel to pass under the South Station rail yards. Alternatives which include a tunnel connection with the Central section of the Artery would be in soft ground clay or glacial till, but would have to include consideration of old foundations, piles, and other fill which lies underground. Alternatives which connect the proposed Fort Point Channel tunnel with the existing elevated Artery structure would be part below, part above grade in the vicinity of Northern Avenue. In all cases, construction staging would have to be devised to permit continuous operation of existing rail and road operations in the South Area.

Artificial ventilation of road tunnels is required where the noxious and toxic gases and smoke emitted from the exhausts of vehicles become either a danger or a nuisance. The principal hazard is carbon monoxide, and the principal nuisance is reduced visibility caused by smoke and moisture. The concentration of these and other contaminants tends to vary with the tunnel cross-section, grade and length; the number, size, speed, load and engine type of the various vehicles using the tunnel; the kind of ventilation provided; the source and quality of the fresh air entering the tunnel either by natural or mechanical means; and altitude and wind conditions. The tunnel designer is limited to control of cross section, grade and ventilation, and these have to be combined to produce acceptable results under the worst conditions.

Design considerations must also be given to the effect of tunnel exhaust on surface conditions above. Contaminants are no more acceptable outside than inside the tunnel, so dispersion of the fumes is essential. Traffic noise, fan noise and air noise must be absorbed or attenuated; and the location and velocity of intake and discharge must be carefully established. The number, location, area, height and appearance of intake and discharge structures must not create audible, visible or smellable nuisances. They can in the alternatives for the South Area, avoid the taking of private property.

III.D ASSESSMENT OF IMPACTS

This discussion summarizes findings of analyses of nine alternatives for the South Area of the Central Artery corridor. It is based upon past studies and analyses of current proposals for South Area improvements, the detailing of transportation impacts of the current proposals, and the social, economic and environmental consequence of alternative improvements. The following sections include a summary of findings resulting from the analysis--presented in the form of two charts, with explanations in the text which follows (see Figures 33 and 34). For purposes of analysis, it has been assumed that the Fort Point Channel tunnel in Alternatives 4-9 will consist of three northbound lanes, with a shoulder used in peak periods to accomodate traffic demand.

III.D.1 Transportation Operational Improvements

Length of Queues

Queues in the South Area of the Artery Corridor are associated with access into it from the south and with the capacity of the Dewey Square Tunnel. Principal queue areas are found on the Southeast Expressway and Mass. Turnpike entrances to the Artery. Because of the limited capacity within the Dewey Square Tunnel, the effect is a metering of traffic between the queues and the Tunnel.

Removal of the queues through each of the no-build alternatives (1,2, and 3) is not possible; they can only be mitigated in minor ways, unless a major widening of the Dewey Square Tunnel is undertaken.

Queuing on the proposed split alignment alternatives (4 through 9) will be less because the capacity of the proposed facilities will be increased, and additional surface street options and connections will be made available within the South Area. For example, the proposed northbound ramp to Northern Avenue and ramps to and from Atlantic Avenue will assist in distributing traffic which now must pass through the queue at the mouth of the Dewey Square Tunnel.

Metering of traffic from the South Area of the Corridor into the Central Area will be partially retained in Alternatives 4,5 and 6 which do not include reconstruction of the Central Area. In those instances, it may be essential to seek alternative means for distribution of traffic which minimizes the use of the Central Area for local downtown access. This would retain the capacity of the central portion of the Artery for through movements or for longer distribution trips within downtown. The reverse direction from the Central Area into the South Area of the corridor should not result in difficulties in queueing, because the capacity of the South Area in Alternatives 4,5 and 6 will be somewhat greater than that of the Central Area.

<u>Annual Delay Reduction (hours in peak periods)</u>
Delay reductions on the Artery are expressed in the following list. (Note that this does not include delay reduction on either connecting expressway facilities or on local surface streets.) Average vehicle speeds in peak periods are also shown for each alternative.

<u>Annual Delay Reduction (hours in peak periods)</u>

Alternative 1 - None at opening, delay to increase over time as congestion builds
Alternative 2 - 53,600 hours
Alternative 3 - 114,000 hours
Alternative 4 - 408,000 hours
Alternative 5 - 742,000 hours
Alternative 6 - 847,000 hours
Alternative 7 - 1,061,000 hours
Alternative 8 - 1,121,000 hours
Alternative 9 - 1,156,000 hours

<u>Average Vehicle Speed in Peak Period</u>

Alternative 1 - 19 mph
Alternative 2 - 20 mph
Alternative 3 - 21 mph
Alternative 4 - 27 mph
Alternative 5 - 28 mph
Alternative 6 - 28 mph
Alternative 7 - 40 mph
Alternative 8 - 40 mph
Alternative 9 - 40 mph

IMPACTS	ALTERNATIVES ALTERNATIVE 1: No Build	ALTERNATIVE 2: No Build with Special Purpose Tunnel	ALTERNATIVE 3: No Build with General Purpose Tunnel	ALTERNATIVE 4: Reconstruction ohly	ALTERNATIVE 5: Reconstruction with Special Purpose Tunnel	ALTERNATIVE 6: Reconstruction with General Purpose Tunnel	ALTERNATIVE 7: Reconstruction with Central Area reconstrution	ALTERNATIVE 8: Reconstruction with Central Area reconstruction and a Special Purpose Tunnel	ALTERNATIVE 9: Reconstruction with Central Area reconstruction and a General Purpose Tunnel
Length of AM queue northbound (miles)	1.80 miles	1.70 miles	1.50 miles	0.70 miles	0.40 miles	0.35 miles	minimal	minimal	minimal
Annual delay reduction (hrs in peak periods)	none; delay to increase over time	53,600	114,000	408,000	742,000	847,000	1,061,000	1,121,300	1,156,000
Average vehicle speeds (in peak periods)	19 mph	20 mph	21 mph	27 mph	28 mph	28 mph	40 mph	40 mph	40 mph
Annual value of time saved - auto driver and passr	none; travel time penalties over time	$494,500	$908,000	$1,986,000	$2,166,000	$2,306,000	$2,667,000	$2,759,000	$2,896,000
Annual value of time saved - bus passenger	none; travel time penalties over time	$ 89,400	$164,000	$ 614,200	$ 890,000	$1,016,000	$1,273,000	$1,505,600	$1,608,400
Annual value of vehicle hours saved - buses	none; travel time penalties over time	$ 5,200	$ 9,500	$ 35,700	$ 51,700	$ 59,300	$ 74,000	$ 87,500	$ 93,400
Annual value of veh. hrs saved - commercial veh.	none; travel time penalties over time	$ 6,500	$ 15,200	$ 31,700	$ 66,900	$ 147,900	$ 152,700	$ 153,900	$ 155,900
Annual operating savings - all vehicles	none; increased costs over time	$ 8,600	$ 24,000	$ 83,500	$ 92,100	$ 107,500	$ 142,400	$ 146,800	$ 152,300
Annual number of accidents	450	430	405	181	149	143	115	105	105
Annual accident reduction - percent	none	-5%	-10%	-60%	-67%	-68%	-74%	-77%	-77%
Annual accident reduction - dollar savings	none	$ 50,800	$101,600	$ 990,000	$ 1,105,200	$1,122,100	$ 1,220,000	$1,270,200	$1,270,200
Interstate standards	no	no	no	improved	improved	improved	improved	improved	improved

Note: For purposes of analysis, No Build Alternatives do not include major alterations to existing structures

Figure 33 Summary of Anticipated Transportation Impacts

IMPACTS / ALTERNATIVES	ALTERNATIVE 1: No Build	ALTERNATIVE 2: No Build with Special Purpose Tunnel	ALTERNATIVE 3: No Build with General Purpose Tunnel	ALTERNATIVE 4: Reconstruction only	ALTERNATIVE 5: Reconstruction with Special Purpose Tunnel	ALTERNATIVE 6: Reconstruction with General Purpose Tunnel	ALTERNATIVE 7: Reconstruction with Central Area reconstruction	ALTERNATIVE 8: Reconstruction with Central Area reconstruction and a Special Purpose Tunnel	ALTERNATIVE 9: Reconstruction with Central Area Reconstruction and a General Purpose Tunnel
Direct tax base impacts	no change	no change	no change	slight positive	slight positive	slight positive	positive	positive	positive
Net new acres for development	none	none	none	1.9 acres	1.9 acres	1.9 acres	5.6 acres	5.6 acres	5.6 acres
Dollar value of land for new development	none	none	none	$2,674,000 to $4,980,000	$2,674,000 to $4,980,000	$2,674,000 to $4,980,000	$7,924,000 to $15,726,000	$7,924,000 to $15,726,000	$7,924,000 to $15,726,000
Impact on community quality and character	no change	no change	no change	slight positive	slight positive	slight positive	slight positive	slight positive	slight positive
Air quality impacts Tons/year	CO: 4990 HC: 620 NO_x: 760	CO: 4970 HC: 620 NO_x: 780	CO: 5070 HC: 630 NO_x: 770	CO: 3720 HC: 540 NOx: 990	CO: 3010 HC: 490 NOx: 1010	CO: 3020 HC: 490 NOx: 1030	CO: 3140 HC: 530 NOx: 1270	CO: 3000 HC: 510 NOx: 1210	CO: 3000 HC: 500 NOx: 1210
Noise impacts	no change	no significant increase or decrease	no significant increase or decrease	no significant increase or decrease	no significant increase or decrease	no significant increase or decrease	slight improvement north of Dewey Sq Tunnel	slight improvement north of Dewey Sq Tunnel	slight improvement north of Dewey Sq Tunne
Water quality impacts	no change	no change	no change	improvement in Fort Point Channel	improvement in Fort Point Channel	improvement in Fort Point Channel	improvement in Fort Point Channel	improvement in Fort Point Channel	improvement in Fort POint Channel
Overall impact - Dewey Sq.Tunnel area	negative	negative	negative	positive	positive	positive	major positive	major positive	major positive
Overall impact - South of Dewey Sq. Tunnel	negative	negative	negative	positive	positive	positive	positive	positive	positive
Project life	30 yrs-decks	30 yrs-decks	30 yrs-decks	40 yrs-tunnel 30 yrs-decks	40 yrs-tunnel 30 yrs-decks	40 yrs-tunnel 30 yrs-decks	40 yrs-tunnel 30 yrs-decks	40 yrs-tunnel 30 yrs-decks	40 yrs-tunnel 30 yrs-decks
Construction Costs - South Area Artery project (000)	$10,640	$10,640	$10,640	$190,580	$190,580	$190,580	$190,580	$190,580	$190,580
Construction Costs - Related projects (000)	none	$409,940	$634,420	none	$312,760	$390,720	$875,000	$1,187,761	$1,265,720
Construction duration	one year	1 year plus 4 years for tunnel	1 year plus 5 years for tunnel	three years	3 years plus 4 years for tunnel	3 years plus 5 years for tunnel	three years	3 years plus 4 years for tunnel	3 years plus 5 years for tunnel
Types of construction disruption	Moderate to severe	Moderate to severe	Moderate to severe	Minimum to Moderate	Minimum to Moderate	Minimum to Moderate	Minimum to Moderate	Minimum to Moderate	Minimum to Moderate

Note: For purposes of analysis, No Build Alternatives do not include major alterations to existing structures

Figure 34 : Summary of Environmental & Community Impacts

Annual Value of Time Saved in Peak Periods

Figure 33 illustrates the benefits of time savings to varying road users, projected as a result of implementing each of the alternatives. These figures are expressed for the year in which each alternative would be open and used; values are expressed in 1975 dollars for comparative purposes. Each alternative also reflects highway system analyses which include induced, new and diverted trips resulting from implementation of the proposed improvements.

A conservative approach has been adopted in presenting the anticipated benefits; that is, benefits are shown only for peak hours (7:00 - 9:00 a.m. and 4:00 - 6:00 p.m.) and only for users of the South Area of the Artery Corridor. Benefits from the implementation of proposed improvements in other portions of the Artery Corridor are not included in the chart. The chart thus gives a modest picture of anticipated benefits, however the analysis has been expanded below for comparative purposes.

In addition to the value of time savings shown in Figure 33 for auto drivers and passengers, bus passengers, commercial vehicles and buses, the following chart shows total savings accruing to all users for each alternative.

Annual Value of Time Saved for All Users

Alternative 1 - None
Alternative 2 - $ 595,600
Alternative 3 - $1,096,700
Alternative 4 - $2,667,600
Alternative 5 - $3,174,600
Alternative 6 - $3,529,200
Alternative 7 - $4,166,700
Alternative 8 - $4,506,000
Alternative 9 - $4,753,700

Annual Operating Savings in Peak Periods - All Vehicles

Costs of operating vehicles are major for all users, and especially so in peak periods when delays and queueing most often occur.

The following chart shows the operational savings for all vehicles which result in peak periods following implementation of each of the alternatives. These benefits are expresses for the year in which each alternative would be open for use; they are shown in 1975 dollars for comparison.

Alternative 1 -	none
Alternative 2 -	$ 8,600
Alternative 3 -	$ 24,000
Alternative 4 -	$ 83,500
Alternative 5 -	$ 92,100
Alternative 6 -	$107,500
Alternative 7 -	$142,400
Alternative 8 -	$146,800
Alternative 9 -	$152,000

III.D.2

Safety

Accident Reduction

The table below reflcts estimated annual accidents for each of the alternatives, including the percent of reduction from the base case (Alternative 1) and the dollar value which is assignable to the accident reduction for each.

Alternative	Annual No. Accidents	Percent Reduction	Dollar Savings
1	450	-0%	none
2	430	-5%	$ 50,800
3	405	-10%	$ 101,600
4	181	-60%	$ 990,000
5	149	-67%	$1,105,200
6	143	-68%	$1,122,100
7	115	-74%	$1,220,000
8	105	-77%	$1,270,200
9	105	-77%	$1,270,200

Interstate Standards

Alternatives 1, 2 and 3 do not meet interstate standards. Improvements will not change Artery conditions relative to these standards. Alternatives 4 through 9 will improve roadway configuration and performance, bringing the Artery close to conformance with the standards.

Regional and Community Impacts

The Artery affects the economic vitality of all of Downtown Boston, which is not only the core of the metropolitan area, but the economic and cultural focus of the New England Region. The proposed improvement alternatives affect both the local community and the metropolitan and New England Regions in different ways.

Alternatives 1, 2 and 3 provide no opportunities to enhance the growth and development of Downtown Boston. Even if operational improvements were made, the negative effects of the present facility would remain. Traffic would continue to spill onto local streets to avoid the Artery, and the negative impacts of the Artery on adjacent land parcels would continue to constrain development possibilities. The improvements of Alternatives 1, 2 and 3 not only continue the negative impacts of the Artery, but prolong the period of these impacts of the present facility into the long-range future.

Alternatives 4 through 9, on the other hand, afford the possibility of implementing a long-range strategy for the improvement of the economic future of the Downtown area. The removal of the constraint posed by the Artery will enhance development possibilities on lands which are adjacent t the Artery. In addition, new opportunities arise for development on the decks over the tunneled Artery. In transportation terms, the impacts caused presently by spillover of traffic onto local streets will be reduced. Improved accessibility resulting from the rebuilt Artery will enhance properties within and adjacent to the Artery Corridor. Since much of this property is in the heart of the metropolitan area, this is a major benefit for the implementation of state and federal policy aimed at the restoration and enhancement of older urban centers. Improvements made through Alternatives 4 through 9 will last only for the immediate future, but also for the very long-term future of Downtown Boston.

Tax Base and Development Impacts

Alternatives 1, 2 and 3 would have no impacts on the tax base nor would they provde new acreage for development. Alternatives 4 through 9 have tax base impacts in both the taking of properties and the reinstitution of new uses made possible through the highway improvements. Tax losses would be incurred if the Sheraton Building were to be taken along with other commercial buildings in the vicinity of Northern Avenue. These losses could be offset with the possible positive tax advantages resulting from the development of new buildings on parcels created within the highway right-of-way, above the new tunnels. Alternatively, if the tunnel is constructed between the Fort Point Channel and a reconstructed Central Area of the corridor, several of the buildings, such as the Sheraton Building, could be saved through underpinning for tunnel construction.

Impact on Community Quality and Character

This is an overall impact evaluation of factors which are difficult to quantify but which reflect community and environmental concerns. These include visual and aesthetic qualities, pedestrian amenities and the local street pattern and its relation to the expressway network.

Alternatives 1,2, and 3	No change in community quality or character over the present situation. The present negative influence of the transportation facilities in the area will continue.
Alternatives 4, 5 and 6	In the vicinity of Northern Avenue, these alternatives may continue some of the present impacts of traffic extending from the Dewey Square Tunnel to the elevated viaduct in the Central Portion of the Corridor.

Ramps from the northbound tunnel in either the Atlantic Avenue or the Fort Point Channel alignment would extend from underground to the existing Artery via a long ramp. This ramp would pass over Northern Avenue and join the elevated highway near Harbor Towers. The ramp would be carefully designed to avoid potential negative impacts on adjacent land uses.

Between Northern Avenue and the Kneeland Street area, both split alignment alternatives are in tunnel and would have community impacts only in the vicinity of entrance and exit ramps. The precise location of these ramps would be determined through more detailed study. South of Kneeland Street and extending to a point south of the Massachusetts Avenue interchange, all alternatives are identical in terms of potential community impacts. The existing alignment of the Artery would be retained with modifications to surface frontage roads and some potential widening of the expressway to allow for construction staging or safety and capacity improvements. This widening, if carried forward, woudl be carefully considered to avoid impacts on the community and to adjust ramp connections to fit closely with desired surface street patterns.

Alternatives 7, 8 and 9 — In the vicinity of Northern Avenue, each of these alternatives would be entirely underground. This would allow for greater flexibility in development of surface land uses and development parcels. For example, it may be possible to retain the Sheraton Building by underpinning the structure with tunneling under the building. The aerial connection between the South split alignment and the existing elevated Artery would be avoided. Community impacts would thus become considerably more positive in this area.

South of the Northern Avenue area, the potential impacts on community quality and character are the same as those described for Alternatives 4,5 and 6 above.

<u>Overall Impacts</u>

Alternatives 1, 2 and 3 which provide only for rebuilding of the existing facility will have continued negative traffic and environmental impacts on this portion of the Corridor. Difficult traffic movements, both on the expressway and on local streets will continue to affect local communities. Without further work or alterations, community impacts in this area will include spillover of traffic onto local streets which are inadequate to handle the demand.

Alternatives 4 through 9 will provide a reconstructed facility to reduce congestion and delays in the area, and decrease accidents on expressways and local streets. Environmental impacts in the vicinity will be significantly reduced because of removal of certain of the transportation impediments which exist today. Opportunities for new development are limited - appearing principally in Alternatives 7,8 and 9 which provide new parcels adjacent to some of the most actively used and highly priced lands in the Commonwealth.

III.D.4

Environmental Impacts

Air Quality Impacts

The proposed changes to the Central Area which potentially affect air quality in the area include:

A. Changes in traffic volumes and speeds using the existing expressway corridor will affect gross emissions areawide under all alternatives.

B. Changes in pollutant dispersion would occur throughout the South Area, if the South Section of the Artery is reconstructed (Alternatives 4 through 9). This would mean the enclosure within a tunnel of the northbound lanes of the highway, and channeling of emissions from this section into additional ventilation stacks. These new stacks would become point sources, replacing the existing line source of the open roadway.

As a first-cut estimate of air quality impacts of the South Area project, calculations of gross pollutant emissions were carried out for each of the nine project alternatives. All calculations were performed using 1975 A.M. peak traffic volumes. Emissions factors used were 1975 average emissions factors from the EPA Compilation document, Supplement 5; as in the No-Build case (defined above as the "Existing" air quality situation), these emissions factors were speed-corrected to correspond to predicted speeds on individual links. The resulting emission totals of CO, HC and NO_x associated with all alternatives are presented in Figure 35.

Generally speaking, all of the reconstruction alternatives produce smaller quantities of CO and HC emissions than the No Build alternatives; e.g., Alternatives 4 and 7, which include no additional harbor tunnel, are preferable to Alternatives 1,2, and 3 in terms of CO and HC pollutant burden. However, the No Build alternatives emerge as more desirable in terms of NO_x emissions when compared with the reconstruction alternatives.

Finally, any new surface ventilation stacks which are required to accompany roadway construction in tunnels will become "point sources" of automotive pollutants. The design and location of such stacks for the area in the Fort Point Channel (assuming the South Section is reconstructed in

Figure 35

Gross Pollutant Emissions
Central Area Alternatives

Alternative	Pollutant Emissions tons/year CO	HC	NOx
1 - No Build	4990	620	760
2 - No Build & SP	4970	620	780
3 - No Build & GP	5070	630	770
4 - South only	3720	540	990
5 - South & SP	3010	490	1010
6 - South & GP	3020	490	1030
7 - South & Central	3140	530	1270
8 - South & Central & SP	3000	510	1210
9 - South & Central & GP	3000	500	1210

SP = special-purpose third harbor crossing
GP = general-purpose third harbor crossing

Variations among the alternatives may occur because of:

- differences in demand associated with capacity differences among the alternatives;
- changes in speeds from link to link according to capacity and demand (emissions of all three pollutants are speed dependent);
- minor differences among alternatives in length of roadway, resulting in changes in overall vehicle-miles of travel even when volumes are constant.

tunnels, as proposed in Alternatives 4 through 9) as well as the detailed analysis of air quality impacts of additional stacks, are steps to be accomplished at a later stage of planning for this project.

Noise Impacts

Several of the changes associated with the various South Area alternatives have the potential to affect noise levels in adjacent areas. These changes, and their like effects, are discussed below.

Throughout the South Area of the Artery, changes in traffic volumes generated by different alternatives result in relatively minor increases or decreases in volumes traversing individual links; these changes should have little or no effect on areawide noise levels. However, many of the existing ramps and expressway access would be re-constructed to accomodate the proposed Artery changes. Such design changes would possibly cause some increases or decreases in noise levels for a specific street corner, row of buildings, etc. These changes would be both minor and extremely localized; they can more properly be addressed at a later stage of the planning process, when specific designs for such connections become available.

The South Area project itself probably will not cause any noticeable increase or decrease in noise levels in the corridor. Noise levels are already so high that the area will be evaluated in terms of possible noise abatement measures, which can be implemented as part of the South Area project.

Water Quality Impacts

Alternatives 1,2 and 3 will provide no change in water quality in the South Area of the Corridor. Alternative 4 through 9 which require the construction of tunnels for the Artery will result in significant changes in the ways in which water is now collected and carried off throughout the corridor. Following construction, all alternatives will likely result in a positive impact on water quality as a consequence of roadway runoff control. Plans for the project not only fit with overall plans to improve the quality of water runoff within the Downtown area, but may provide an incentive to advance the plans for water outfall treatment and control through integrated construction of the highway and water pollution control facilities, particularly in the Fort Point Channel.

III.D.5 Costs, Construction Duration and Disruption

Project Life
All deck replacement work anticipated in the alternatives will have a service life of 30 years. All tunnel construction will have a service life of 40 years.

Construction Costs - South Area
Construction costs for the no-build alternatives (1,2 and 3) are $10,640,000 in the South Area. This includes only the costs of concrete deck replacements on the existing Artery facility. Modifications to the Dewey Square Tunnel are not included in this estimate. Construction costs for alternatives 4 through 9 - the split alignment alternatives - are $190,580,000. This includes connections into the existing facilities on the extremeties of the project, and improvements to the approaches from expressways and local streets.

These costs are only for improvements to the Artery itself in the South Area, and exclude related projects such as the third harbor crossing and the north and south portions of the corridor. The costs of related projects are listed below.

Construction Costs - Related Projects
Alternative 1 - no related projects
Alternative 2 - Special Purpose Harbor Tunnel from Bradway to E. Boston - $407,940,000
Alternative 3 - General Purpose Harbor Tunnel from Broadway to E. Boston - $634,420,000
Alternative 4 - No related projects
Alternative 5 - Special Purpose Harbor Tunnel: $312,760,000
Alternative 6 - General Purpose Harbor unnel: $390,720,000
Alternative 7 - Reconstruction of the Central Area of the Artery: $1,015,000,000

Alternative 8 - Reconstruction of the Central Area of the Artery: $1,015,000,000 and Special Purpose Harbor Tunnel: $312,760,000

Alternative 9 - Reconstruction of the Central Area of the Artery: $1,015,000,000 and General Purpose Harbor Tunnel: $390,720,000

Note: the construction cost estimates for the Harbor Tunnels are less if the split alignment of the Fort Point Channel is part of the South Area reconstruction because it includes the tunnel approaches between Broadway and the Northern Avenue Bridge.

Types of Construction Disruption

Alternatives 1,2, and 3 — In order to maintain traffic on the expressways, the decks would have to be replaced one lane at a time. This would result in moderate traffic disruption for the duration of the construction period. If ramps are reconstructed, the work would be phased jointly with deck replacement.

Alternatives 4 through 9 — Reconstruction of the Artery, by providing new tunnels for the roadway, will result in disruption only at the locations where connections between the new tunnel and the existing roadway must be provided. At such locations, the overall goal is to disrupt Artery traffic minimally. This will be accomplished by making replacement lanes available for existing traffic at all times throughout the construction period. Detailed design of the proposed project is essential to determine the nature of disruption potential and the mitigating measures which must be undertaken to modify impacts on local communities, local and expressway traffic and on businesses throughout the corridor.

CHAPTER IV. PUBLIC PARTICIPATION

IV.A PRCCESS

Public involvement has led toward the development of this document, as an integral part of the process of discussing issues and designing proposals which meet community needs. The current process began with the community concerns about the construction of transportation improvements in the area, and the subsequent study of changes to the Artery carried out through the Boston Transportation Planning Review and a subsequent study conducted by the Boston Redevelopment Authority for the Mass. Department of Public Works.

IV.B PUBLIC INVOLVEMENT PROGRAM

A slide show was developed to provide information to the public on the overall program for proposed improvements to the Artery corridor and to generate comment from concerned citizens. The slide show has been presented to interested community groups and individuals, public agencies and responsible officials, and organizations with regional focus.

A working committee of local and regional interests was established to review the proposed improvements to the Artery corridor. A selected list of representatives from the South Area was developed and is now included on all mailings, literature distributions, and invitations to working committee and other public meetings.

In addition to the slide show and working committee meetings, special briefings have been held with specific interests in proposed South Area improvements. They include Boston city officials, property owners, private organizations, and agencies which have a interest in the area, such as MassPort and the Mass. Turnpike Authority.

Through the above activities, a draft Corridor Planning Study was prepared for the South Area. This document was distributed to key community representatives, discussed in briefings, distributed to regional organizations and public agencies and was the subject of a working committee meeting on October 17, 1977. Comments resulting from meetings have been incorporated into this chapter and other parts of this document. A detailed listing of comments is included in this chapter.

IV.C PUBLIC COMMENTS AND RESPONSES

South End Community Review - September 29, 1977

Comments were made on the comprehensiveness of the document, with suggestions that mention should be made of:

1. Problems of the present ramps leading between E. Berkeley Street and the Artery.

2. The Artery congestion causes through traffic to seek local street alternative routes.

3. The Artery prohibits direct connections between the South End and South Boston, particularly for buses.

4. The aesthetics of the Artery are of concern.

5. There is no local service provided by the Turnpike.

6. The three-lane bridge on the Artery at the Massachusetts Avenue interchange is a bottleneck between the Artery and the Southeast Expressway.

7. There is an existing agreement between the South End Committee on Transportation and the City of Boston in regard to the use of local streets for through movements.

8. The routes for traffic during construction in the no build options should be outlined.

9. The environmental and engineering analysis should include: a. noise impacts on housing abutting Albany Street and the hospitals, perhaps also New England Nuclear and Gillette; b. economic benefit analysis of a more rational truck access pattern which does not impact residential communities; c. definition of project boundaries to include all of the Massachusetts Avenue interchange with the Artery; d. capacity analysis to assure that initial construction with provision for construction of

a Third Harbor Crossing does not attract excess traffic, along with examination of ways and means of retaining present traffic volumes with no increases; e. local and regional energy uses; f. value capture through improvements and analysis of who benefits and pays; g. inter-relation with the Southeast Expressway; h. less optimistic air quality analysis.

This question was answered by a statement that re-uses of the surface can be included in the environmental and engineering work which is to be done. It is a subject that can be resolved only with more examination of the surface street needs and engineering analysis of the bearing capacity of the present tunnel.

2. Where is the parking access to the new South Station complex to be provided?
All access to South Station parking is presently planned to be accomodated on Atlantic Avenue.

3. Which alternative does the State prefer?
The present corridor location is preferred, but the specific alternative has not been determined, pending additional information.

4. Why have the ramps in the existing tunnel been closed?
The ramps have been closed for safety reasons.

5. What guarantees do we have that the development of the plans will not encroach upon Chinatown, even though they do not do so at present?
The state has no intention of further encroaching on Chinatown; decisions on alternative designs will be the subject of more detailed analyses including additional community meetings and review sessions.

6. What do the developers around the Fort Point Channel think of the proposal for a new tunnel?
To date, the property owners and business people appear to be positive toward the proposal no objections have been raised to the proposal as presently developed.

<u>Central Artery Working Committee - Oct. 17, 1977</u>

An overview of the progress of all aspects of the Artery work was presented, followed by an invitiation for comments and criticism of the South Area Corridor Planning Study. Questions were raised as follows:

1. What are the Third Harbor Crossing conclusions? Response: a full scale traffic analysis is envisioned in subsequent environmental and engineering work to ascertain potential volumes and traffic impacts on South Area proposals.

2. Are there any further specific designs on the Fort Point Channel alignment? Response: No Major concerns about the alignment are principally the environmental impacts and the considerations of the existing red line transit tunnel in the channel. Most of the Boston Conservation Commission objectives have been met in improving the water's edge.

3. Which part of the proposal is in the Channel, and which part on land? Response: this will become a major part of the detailed work ahead; further details have not yet been developed .

4. Will the consultants for the South Area analyze these alternatives? Response: yes.

5. What is the relationship to the proposed Seaport Access Road? Response: both are physically and functionally related. The Seaport Access Road is currently undergoing environmental analysis, with 5 alternatives derived from the initial work. The project is briefly covered on page 76.

6. What are the negative impacts on the Fort Point Channel? Response: the channel may be narrowed; the proposed tunnel may not be below water level, because of the need to pass over the existing Red Line transit tunnel; post office operations are a major constraint on alignment choices.

7. What are the positive impacts on the Fort Point Channel? Response: development on the edge of the channel - a park strip, pedestrian way, marina, etc.; cleanup of the present sewer outfalls into the channel.

8. Will the South Area consultant be concerned with urban design. Response: absolutely.

9. Where are the locations for a potential arena? Response: locations being considered are south of Summer Street.

10. What about longer range land uses, especially air rights over the Expressway? Response:

air rights development is not out of the question, but may be difficult in areas such as the interchange with the Turnpike.

11. Does the document relate the South Area proposals with the South Station plans? Response: it provides for the eventual and the short-range improvements to South Station.

12. What is the year for the projected benefits of the various proposals? Response: the year of opening; this has been added to the text.

13. What is the level of federal support for this work? Response: federal review of this and other such documents will lead toward EIS work; there have been no indications that they will not allow EIS work following acceptable documentation of corridor planning studies.

14. Will you be having additional community meetings? Response: the community review process will continue for these documents through November and December, with a more complete involvement process if the documents are approved by the federal government.

15. The Southeast Expressway work is being done without community participation; expansion of the expressway capacity, especially inbound must have participation, and study of what can be done at, for example, the Berkeley Street ramps. What is the process to obtain community involvement in this area? Response: The Mass. DPW is reviewing currently the possibility of looking at a lane configuration for the Southeast Expressway that would be 3-2-3 instead of the present 3-3 with breakdown lanes. If this is to be extensively examined there will be public hearings on the proposals.

16. If the entire Artery project is built, in North, South and Central Areas, where will future bottlenecks occur? Response: none in the North are foreseen; some may remain in the South because of the restricted capacity of the Southeast Expressway. This will need close examination.

17. General comments for possible additions to text:
Albany Street will be a major bypass while construction is being undertaken, because

there is no connection between City Hospital and the northbound Artery access roads. Reference should be made that the present interchange at Mass. Ave. is substandard, and must be rebuilt, even in a no-build alternative.
There is serious question, from a neighborhood point-of-view, that capacity should be increased in the area. Traffic might be metered into town, for example, at the Braintree entry point to the Southeast Expressway. Three lanes in and four lanes out of town should be examined. The question should be examined as a policy issue; there may be an upper limit on traffic in the whole corridor. Transit may have more to do with limiting traffic than what is done to improve this road.
There are existing agreements between the City and its neighborhoods that must be acknowledged in planning Artery improvements. Impacts are too often posed in terms of level of traffic service vs. community impacts; a low level of service in Braintree may be best for this area, to deter traffic from entering the corridor.
Most radial traffic may be to the Southwest - not the Southeast. - thereby putting pressure on the local streets which connect with the Artery in the vicinity of Mass. Ave. This pressure may have been underestimated.
An additional alternative alignment for the Artery in the rail yards south of South Station (betwen the city public works building and the MBTS yards) should be examined.
The projectneeds to relate traffic problems to the potential changes in life styles; how can impacts be reduced, and how can auto dependence be reduced.

All of the above comments in item 17 may be more appropriately dealt with in the EIS work which is yet to come.

Comments received in Questions 1 through 9 have been incorporated into the body of the report as appropriate. Questions 1 through 4 are dealt with in revisions in the text on pages 19 through 23. Question 6 is discussed on page 64. Other questions have been noted for future analyses.

Dewey Square Study Committee - Oct. 6, 1977

At this meeting of the several property owners and businesspeople in the area surrounding Dewey Square and South Station, a brief presentation followed earlier discussions of a proposed new arena and South Station plans. All planning for the area is now proceeding on the basis of the Mass. DPW alignment for a new Fort Point Channel Tunnel for northbound Artery traffic. It was noted that a new arena would require substantial public investments for connections into the Artery improvements. The South Station proposal now being advanced does not require separate Artery ramps; access for vehicles to and from parking will take place on Atlantic Avenue.

Because of the extensive number of items on the agenda, there was little time for questions. One questions was posited: does the Sheraton Building have to be taken in all alternatives? The questions was answered with reference to pages 113 and 114 of this document. The building can be retained by underpinning in Alternatives 7,8 and 9.

Chinatown Community Review - Oct. 13, 1977

A meeting of the Chinese Benevolent Association included an opportunity for presentation and review of the Corridor Planning document with a large number of Chinatown community leaders. The presentation was made orally, chapter by chapter, with translation following each paragraph. Copies of the document were made available for subsequent individual review.

Questions which were asked included the following:

1. What is the potential for re-use of the present surface Artery in the reconstruction proposals? Can it be returned to the Chinese community? Is it possible to build over the present tunnel with small one-story shops or open space?

This question was answered by a statement that re-uses of the surface can be included in the environmental and engineering work which is to be done. It is a subject that can be resolved only with more examination of the surface street needs and engineering analysis of the bearing capacity of the present tunnel.

2. Where is the parking access to the new South Station complex to be provided?
All access to South Station parking is presently planned to be accomodated on Atlantic Avenue.

3. Which alternative does the State prefer?
The present corridor location is preferred, but the specific alternative has not been deterined, pending additional information.

4. Why have the ramps in the existing tunnel been closed?
The ramps have been closed for safety reasons.

5. What guarantees do we have that the development of the plans will not encroach upon Chinatown, even though they do not do so at present?
The state has no intention of further encroaching on Chinatown; decisions on alternative designs will be the subject of more detailed analyses including additional community meetings and review sessions.

6. What do the developers around the Fort Point Channel thing of the proposal for a new tunnel?
To date, the property owners and business people appear to be positive toward the proposal' no objections have been raised to the proposal as presently developed.

Improvements to portions of the South Area of the Central Artery will have to be undertaken within the near future. These improvements are principally deck replacements on the expressway in the area of the corridor south of the Dewey Square Tunnel. These decks are deteriorating and will need replacement if no other work is undertaken in the corridor. However, there are substantial problems in the operations of the present facility which should be examined to determine the appropriate course of action.

Operational problems of the present facility in the South Area must be solved within the present corridor. There are no feasible alternatives to the present corridor in which a new or bypass facility can be located. Alternatives to the present corridor have been examined for all alignments which have been discussed in past or present contexts; none of the alternative corridors provides a feasible location for a new facility.

Within the present corridor, there are few alternatives which improve operations of the South Area of the Artery without extensive negative environmental impacts. Widening the present Dewey Square Tunnel, for example, is not an acceptable solution from a community or land damage viewpoint. Double-decking the tunnel is likewise infeasible. Existing land uses and proposed new developments constrain alternative locations for improvements. Two basic alternatives have emerged: the no build which provides for upgrading the present facility; and a reconstruction which includes a new facility in either the Fort Point Channel or under Atlantic Avenue to provide for northbound movement, and a modified Dewey Square Tunnel for southbound movement. These alternatives have been examined in detail particularly with respect to their relationship to projects external to the South Area; i.e., the proposed improvements to the Central Area of the Artery Corridor and a proposed Third Harbor Tunnel, for either general or special purpose use. This analysis led to the examination of nine possible alternatives.

Feasible Alternatives for South Area

The chart below shows the alternative permutations which are possible in the South Area of the Artery corridor Alternative 1 is the basic No Build Alternative with Alternatives 2 and 3 as permutations. Alternative 4 is the basic reconstruction alternative with alternatives 5,6,7,8 and 9 as permutations.

Figure 36: South Area Alternatives

		With 3rd Harbor Crossing	
	Without 3rd H.C.	Special Purpose	General Purpose
NO BUILD	Alt. 1	Alt. 2	Alt. 3
SPLIT ALIGNMENT WITHOUT CENTRAL AREA	Alt. 4	Alt. 5	Alt. 6
SPLIT ALIGNMENT WITH CENTRAL AREA	Alt. 7	Alt. 8	Alt. 9

The No-Build Alternatives

Alternative 1, with deck replacement as its major feature, has two variations- Alternatives 2 and 3 - which include deck replacement in combination with previously developed alignments for a third harbor tunnel project. Alternatives 2 and 3 were examined because: 1. previous alternatives for a third harbor tunnel required study in relation to more current thinking about improvements in the South Area; 2. these alternatives are useful analytically for comparing Artery improvements with an independent Third Harbor Tunnel. Previous studies of a Third Harbor Tunnel identified the Fort Point Channel as the most feasible location for such a facility. However, use of the Channel for a Third Harbor Tunnel, as in Alternatives 2 and 3, would foreclose South Area Split Alignment alternatives, whereas Alternatives 4 through 9 can be used for Artery improvements while preserving the option for connections to a Third Harbor Tunnel at a later date. Alternatives 2 and 3, which do not improve the South Area with the independent Third Harbor Tunnel, cost approximately the same ($600,000,000) as the proposed South Area Split Alignment plus a Third Harbor Tunnel which connects to it. Because Alternatives 2 and 3 foreclose options and do not make Artery improvements beyond those in Alternative 1, they should be dropped from further consideration as potential solutions for the South Area of the Artery. Alternative 1 should be retained for further study. If Alternative 1 is selected for implementation, the question of a Third Harbor Tunnel can be examined on its own merits as a separate project.

Reconstruction Alternatives

Alternatives 4 through 9 represent the various possibilities of a full reconstruction of the South Area for Artery improvements. Alternative 4 is the basic alternative for reconstruction; Alternatives 5 through 9 are permutations which have been included to afford a basis for analysis of the reconstruction as it might relate to subsequent or concurrent related projects. Analysis of Alternative 4 has shown that it is possible to construct a new facility which would improve the transportation operations of the South Area and which would be compatible with concurrent or subsequent development of related projects. Permutations of Alternative 4 which include a Third Harbor Tunnel, but which are otherwise identical to Alternative 4, are Alternatives 5 and 6. Central Area Artery improvements are included in Alternative 7. Alternatives 8 and 9 are permutations of Alternative 7 which include a Third Harbor Tunnel, but are otherwise identical to Alternative 7. Of the six reconstruction alternatives (4 through 9), it is recommended that Alternatives 5, 6, 8 and 9 be eliminated from further environmental and engineering studies in connection with the Central Area and that Alternatives 4 and 7 be carried into further engineering and environmental analysis. They address South Area transportation problems and potential interactions between South Area Artery improvements and other projects, while allowing for the potential later addition of a Third Harbor Tunnel as a separately built, but physically connected future project.

It should be noted that the improvements to the Central Area of the Artery corridor and the construction of a Third Harbor Tunnel are separate projects, serving purposes and having benefits which are different from the reconstruction of the South Area of the Artery corridor. South Area benefits which can be achieved include provision of three lanes in each direction with a shoulder in each direction used in peak periods; fewer ramps to and from the Artery with better spacing between ramps; provision of speed change lanes for ramp traffic; surface frontage roads for collection and distribution of local traffic; and land for development on the decks over the new tunnels. The alternatives which have been developed for the South Area, and which should be carried forward (Alternatives 1, 4 and 7) have inherent flexibility to accomodate related projects while accomodating South Area needs.

Major reconstruction of the South Area of the Artery offers the possibility of implementing a long-range strategy for the improvement of the economic future of Downtown Boston. The Artery affects the economic vitality of all of Downtown Boston, which is not only the core of the metropolitan area, but the economic and cultural focus of the New England Region. The proposed improvement alternatives affect both the local community and metropolitan and New England Regions in different ways.

<u>Detailed analysis of each of the alternatives is necessary. In particular the following tasks should receive special attention.</u>

a. All alternatives require detailed analysis of:

   - construction techniques and phasing
   - traffic maintenance during construction
   - transportation service

- demand/capacity analyses
- surface street impacts
- relation to harbor crossing demand and airport service
- safety during and after construction
- social impacts (regional and local) during and after construction
- social impacts to adjacent neighborhoods and the region, during and after construction
- land use and urban design considerations
- detailed cost estimates
- employment generation

b. Reconstruction alternatives require, in addition, detailed analyses of:

- ventilation requirements
- joint development opportunities
- decking requirements
- tunnelling requirements
- dangerous cargo handling
- joint rail line construction
- rail line service, space requirements

Anticipated Federal Funding Participation

I-93 is the principal North-South route connecting, in the North, the Boston Metropolitan Area to the Merrimac Valley (Lowell and Lawrence), New Hampshire, Vermont and Canada. To the south, it connects the Metropolitan area to the southeast area of the Commonwealth, Cape Cod , Rhode Island, and the eastern seaboard. I-90, the Massachusetts Turnpike, a toll facility, connects the metropolitan area with the western Massachusetts metropolitan area of Worcester and Springfield, New York State, and states west of New York. Traffic problems associated with the interchange of these two roadways are documented in this report. Volumes of traffic on I-93 approximate 135,000 ADT; on I-90, 60,000 ADT.

Certain alternatives described in this document would require the addition, removal and/or realignment of certain ramp connections between these two major interstate routes. Replacement "in-kind" is anticipated.

Any federally-aided highway is subject to the requirement in Section 301 of Title 23, United States Code, Highways, that it be free from tolls (except for certain toll bridges and tunnels as provided in Section 129). This requirement is met. There is no intention of imposing tolls on I-93, nor are motorists using I-93 required to exit through the I-90 tolls. A large portion of I-93 traffic is not interchanging with the Massachusetts Turnpike. While the I-93/ I-90 connection provides a major transfer of traffic between the two interstate facilities, I-93 as part of the interstate system is an essential through route and the major highway in the City of Boston. As long as the present interchange is not improved, motorists on I-93 will continue to experience severe traffic problems from operational and safety viewpoints. If certain alternatives described were solely improvements for an approach to or from a toll facility, then that particular alternative would not be eligible for federal partcipation. This is not the case here.

The improvements described in all alternatives are mainly to improve traffic operational conditions on I-93, not I-90. In view of this, it is the opinion of the Department of Public Works that the formula for funding the chosen alternative be on an Interstate 90:10 basis.

APPENDIX I

Previous Studies Related to the South Area of the Artery Corridor

Over the past 15 years there have been many studies of the transportation problems of the South Area of the Artery corridor. These have resulted in improvements for some situations and a backlog of attempts to correct certain of the Artery problems. The following is a compendium of the studies and subsequent action which has resulted from the studies.

1. Relocated Dorchester Avenue. In 1967, studies were conducted for the MDPW to determine the feasibility of widening the existing Dorchester Avenue. The proposed improvement was for a six-lane roadway in the Fort Point Channel, adjacent to existing Dorchester Avenue. The proposal included filling Fort Point Channel and several alternative construction techniques were examined in order to minimize impacts on the existing Red Line rapid transit tunnels in the middle of the Channel. The proposal required use of the Fort Point Channel alignment, even though special measures would have to be taken to protect the Red Line tunnels. Dorchester Avenue, if improved, would extend to Northern Avenue from its existing terminus at the bridge over the Channel in South Boston. The present right-of-way of Dorchester Avenue would not be used for new improvements, owing to its sale to the U.S. Post Office Department. After consideration of the proposal and its potential conflicts with proposed land uses along the channel, it was dropped from further consideration.

2. Third Harbor Crossing (Howard, Needles, Tammen, Bergendoff, 1968) This study, directed to be undertaken by the Massachusetts Legislature, recommended a six-lane general-purpose tunnel to

be operated as a toll facility. The alignment chosen was the Fort Point Channel on the downtown side of the harbor, to East Boston on the railroad alignment through the middle of the community, with connections to C-1 at the entrance to the airport. The proposal elicited much adverse comment from the community, and led to the need for further examination of the potential alignment and demand for the facility. This work was done in the Boston Transportation Planning Review.

3. <u>Harbor Crossing</u>. The Boston Transportation Planning Review examined proposals for a third harbor crossing between E. Boston/Logan Airport and Downtown Boston. General - and special - purpose tunnels were examined on various alignments. Some alternatives included provision for related operations and service improvements, such as satellite parking, rapid transit improvements, bus-limo service, street improvements and high-speed rail in the NE corridor. The basic alternatives were: (1) a six-lane general-purpose tunnel from downtown to the airport and north to connect to a new expressway serving the north and north shore; (2) a 2-lane special-purpose tunnel between downtown and the airport and no new harbor crossing, but improved rail, bus/limo service and satellite parking; and (3) a No Build Alternative, with Central Artery improvements including bus rights-of-way to the Sumner and Callahan Tunnels along with major transit and service improvements.

At the conclusion of the study, the then governor recommended the construction of a two-way special-purpose tunnel in an alignment in the Fort Point Channel crossing the harbor and surfacing on airport property to terminate at the airport service road. This tunnel was intended to serve only buses, limos, trucks, emergency vehicles and taxis. It was also intended to be supplemented by major transit improvements and by satellite terminals for park-and-ride between suburbs and airport. After presentation and deliberation by the state legislature, no approval was granted to proceed with the tunnel.

4. Deck Reconstruction--Southeast Expressway Reconstruction of deteriorating highway decks on the Southeast Expressway was first suggested in 1973. The original proposals called for replacement of all decks on the Southeast Expressway bridges. Two areas of concern were located within the South Area of the Artery corridor: approaches to both the Dewey Square Tunnel and the Massachusetts Avenue interchange, which are on elevated structures. Because of the extent of deterioration, the Massachusetts Avenue interchange work is now under construction. However, deck replacement at other locations within the South Area has been postponed because of its potential relationship to the Central Artery project in the South Area. Along with the deck reconstruction, other operational efforts are underway to improve capacity and flow on the Southeast Expressway, both during and after construction. These include preferential bus and carpool lanes during rush hours and in peak direction, and the state program to encourage use of transit and carpools.

5. Massachusetts Turnpike Frontage Roads. The BRA recommended in a 1974 statement of South End transportation issues "a state-sponsored environmental assessment and basic design of alternatives for completing a Turnpike frontage road system from Dorchester Avenue and the Southeast Expressway to Dartmouth Street." This would involve a connection of Broadway with Marginal Road and an extension of Herald Street from Arlington Street to Dartmouth Street, along with related street modifications. The road would serve to remove truck traffic from congested South End residential streets.

6. South Boston Seaport Access Road. In September 1976, the BRA and Massport selected a consultant to prepare a draft environmental assessment for a seaport access road in South Boston.

Currently, industrial truck traffic randomly utilizes the South Boston local street system in seeking access to the Castle Island container terminal and other industrial or commercial areas located north of West First Street. The seaport access road has been proposed to end intrusion of industrial traffic onto residential streets and improve the potential for development of South Boston's 600 acres of underused and vacant land. It would supplement joint private and public efforts to revitalize existing commercial and industrial properties in the area north of First Street and west of Summer Street.

7. New Northern Avenue Bridge Over Fort Point Channel and its Approaches. Plans have been advanced for a new fixed-span Northern Avenue bridge approximately 200 feet southwest of the antiquated existing bridge. An EIS has been completed by the MDPW and final engineering studies await the outcome of final determination of the historic worth of the existing bridge and the issues of navigation of the Fort Point Channel. Northern Avenue and its bridge is the most important and heavily used traffic link betweek South Boston and Boston Proper. The bridge is vital for smooth flow of present and future traffic and for improvement of commercial and residential life in the adjacent and deteriorating areas.

8. Lafayette Place. As part of continuing efforts to strengthen the retail shopping core of downtown, Lafayette Place has been designed to house new shops, expansion room for a major department store, and parking for shoppers. The major transportation impacts result from the proposed alterations to the downtown street pattern. Essex Street is proposed to become a major connector into the new development, tying to the Artery corridor at Atlantic Avenue. The new street would be two-way, and would link to the South Station area near Dewey Square. New parking would be approached from the street, and major connections to the Artery corridor would be essential for ready service to the proposed parking facilities.

9. South Station Transportation Center. The most important new traffic generator in the South Area is the proposed 82-acre South Station Transportation Center, presently owned by the BRA and scheduled to be rebuilt by 1980 as an "intermodal transportation center" serving Amtrak inter-city trains and MBTA commuter and rapid transit trains. Public improvements, totaling over $100 million, will include renovation of the existing "head house," and construction of a passenger facilities center and a rail, bus and auto transportation terminal. An EIS has been completed and reconstruction of the old "head house" has begun. The upper levels of the new Transportation Center will provide up to 2,500 parking spaces and may connect directly to the Southeast Expressway and adjacent streets.

10. Crosstown Street, South End. The BRA is currently designing the portion of the Southwest Corridor Arterial Street that runs from Massachusetts Avenue to Tremont and Columbus Avenues. At Massachusetts Avenue, the street ties directly to ramps of the Central Artery. Construction of the arterial street has been declared a non-major action. Actual construction of the arterial will be undertaken by the Massachusetts Department of Public Works.

I. INTRODUCTION

The following material provides technical backup on the approach and methods used in analyzing benefits, impacts, and costs for alternative South Area Central Artery improvements considered in the Central Artery/I-93 Corridor: South Area Planning Study. As in the Study, four areas of impact analysis are considered: operational improvements and benefits, design standards and safety, environmental and community impacts, and construction costs and impacts. Each of these is considered with regard to the various construction options developed in the Study. In some cases, methods of analysis have been taken up fully in the Study, and require little further treatment here. In others, it was appropriate that analysis details be reserved for this document. The methods used are consistent with the "state of the art" in highway planning practice. Sometimes they are qualitative, and sometimes quantitative, depending on suitability as related to the particular impact category being assessed. Also, in analyzing benefits, a conservative approach has been taken to assure that results would not overstate the worth of proposed investments. Finally, it should be noted that the analyses are at this point approximate. While the methods used have probably yielded results of the proper general ordering and magnitude, certain results can be expected to change somewhat as improved data become available and future detailed studies are undertaken.

For convenience, each of the construction options considered is described briefly below:

Alternative 1.

The No Build Alternative has been developed to explore the possibility of retaining the existing facility with some modifications to prolong its useful life. South of the Dewey Square Tunnel, the Artery decks need replacement in the near future if no other improvements are made. In the Dewey Square Tunnel area, modifications could range from minor changes to the tunnel, to widening by adding new lanes.

Alternative 2.

This is similar to Alternative 1, except for the addition of construction of a special purpose Third Harbor Tunnel. The connection between the South Area and the tunnel would be made in the vicinity of the Turnpike and Artery interchange. The two-way tunnel would be located in the Fort Point Channel.

Alternative 3.

This is similar to Alternative 2, except that the tunnel would be a general purpose Third Harbor Crossing.

Alternative 4.

In this alternative, the South Area of the Artery would be reconstructed to provide a new north-bound tunnel of three lanes and a breakdown lane, to be located under either Atlantic Avenue or the Fort Point Channel. It would be connected to the present Central section of the Artery in the vicinity of Northern Avenue. The Dewey Square Tunnel would be retained for southbound movements, but could be modified for better geometrics and lane configuration. New or improved connections would be made to local streets and to the proposed South Station Transportation Terminal. Provisions would be made for connections to a third harbor tunnel if that facility were to be constructed.

Alternative 5.

This is similar to Alternative 4 with the addition of a Special Purpose Third Harbor Tunnel.

Alternative 6.

Similar to Alternative 5 except that the Third Harbor Tunnel would be for general purposes.

Alternative 7.

In this alternative, the South Area would be reconstructed as in Alternative 4 with a connection to a reconstructed depressed Central Area section of the Artery.

Alternative 8.

Similar to Alternative 7 with the addition of a special purpose Third Harbor Tunnel.

Alternative 9.

Similar to Alternative 8 except that the Third Harbor Tunnel would be for general purposes.

II. OPERATIONAL IMPROVEMENTS AND BENEFITS

The assessment of operational impacts usually involves an iterative procedure which relates traffic volumes, design characteristics, and resulting travel characteristics and benefits. Basic travel estimation for the South Area Study was carried out through a manual traffic assignment procedure which utilized 1975 traffic volumes, alternative system characteristics, and various assumptions regarding sources and flows of future traffic. Explicit analyses of queues, delays, and vehicle speeds were then undertaken based on traffic estimates and design characteristics of the different construction options. Travel time and operating cost savings were then calculated based on projected delays and vehicle speeds. Each of these analyses is considered below.

A. Traffic Estimation

The first step in estimating traffic for the South Area was to build a base case network for the No Build Alternative. This network included the present express highway facilities in the South and Central areas, and the surrounding highways and local streets that could experience traffic impacts from South and Central Area Artery improvements. Once this was completed, 1975 traffic volumes were assigned to the major links of the network. Since this process was completed before the data became available from the Central Artery Origin/Destination survey of March, 1977, the best pre-existing available data were used. Both MDPW Automatic Traffic Recorder counts for the Central Artery and its on and off ramps, and manual traffic counts from the City of Boston Department of Traffic and Parking were used to determine 1975 7-9 AM and 4-6 PM peak period volumes for the No Build alternative. Manual adjustments were made to balance traffic flows for internal consistency, and checks were made for reasonableness. Traffic volume data ranged from 1972 to 1977 derived from the various sources. Traffic counts made by the Massachusetts Turnpike Authority and the Boston Redevelopment Authority for special projects were used to work out the final set of 1975 assigned total peak period volumes. Truck volumes were determined from the Southeast Expressway Downtown Express Lane evaluation program.

In assigning traffic to new or improved facilities for the eight "Build" alternatives, the following assumptions were made:

- Increased traffic volumes would occur as a result of route switching and new trips.

- Most of the "new" trips would be through trips (approximately 75%).

- An implied travel time elasticity of -1.2 was used to estimate increased travel based on travel time reductions. Assuming South Area construction but no Central Area project, this resulted in an extra 300 trips in each direction during each of the peak periods. If the Central Area were built in addition to the South Area, this resulted in an extra 500 trips in each direction during each peak period.

- The reduction in total numbers of ramps in the various alternatives was not assumed to reduce the number of trips. These on and off moves were shifted to different ramps on the Artery. It was assumed that improved service levels on the Artery would retain these trips.

- Approximately 100 trips each peak period were assigned to switch from Storrow Drive to the Massachusetts Turnpike due to a new third harbor tunnel for the general purpose option only.

- Route diversion to the improved Artery would occur only from directly parallel routes such as the existing surface streets. Diversion to the improved Artery would be approximately 25% to 33% of existing off-Artery trips on these routes.

- The third harbor tunnel was assumed to carry traffic only between Logan Airport and the southern and western corridors. As a special purpose facility, it was assumed to carry buses, limousines, taxis, trucks, carpools (three or more occupants per vehicle), and vanpools.

- Truck traffic was assumed to be 3.5% of total traffic in the South Area.

The actual traffic assignment procedure for different alternatives was as follows: First, all base case traffic was assigned to each alternative changing only the ramp volumes to reflect the different ramp locations. Second, estimates were made of traffic diverted from parallel roadways. These estimates were based on increased Artery and ramp speeds associated with the improved Artery levels of service that each alternative would allow. As part of this step, new or induced trips were estimated and added to the totals on the Artery. As in Step 2, the new traffic was estimated based on the increased speeds allowed by the proposed new construction. Again, ramp volumes were changed appropriately. The fourth step was to check the final results by computing volume/capacity ratios, and determining whether the Artery and ramp speeds assumed in the second and third steps could be maintained. If not, volumes on the Artery were adjusted downward, and traffic was rediverted onto parallel streets until the assumed speeds could be met.

The entire procedure was completed manually for Alternatives 4, 5, 6, 7 and 9. Alternative 1 (No Build), was, of course, also done as the base case. Artery traffic estimates for Alternatives 2, 3, and 8 were interpolated from numbers for the other alternatives.

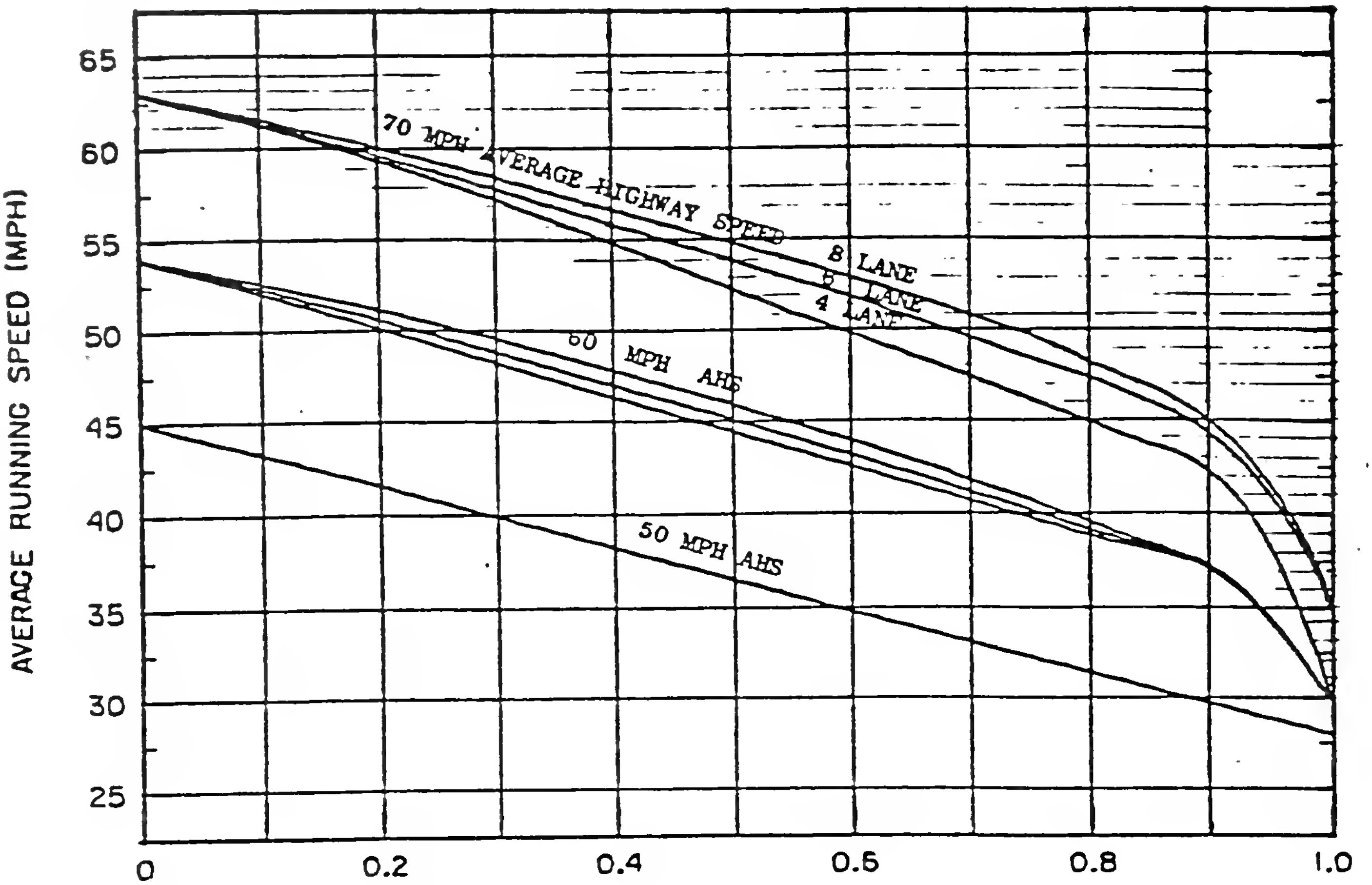
B. Queues, Vehicle Speeds and Delays

In order to calculate queue lengths for different alternatives, it is necessary to compare capacity with demand. In the South Area analysis, the procedure for estimating queues was drawn largely from NCHRP Report #133 by Curry and Anderson.[1] Peak period demand from the traffic assignments was compared with the capacities of the alternatives (at service level "E") for the highway sections upstream from the queue, within the queue, and at the bottleneck. This yielded rate of queuing and speeds for the sections of highway. Rate of queuing was simply the difference between the demand at the bottleneck and the capacity at the bottleneck, expressed in vehicles per hour. Speeds in the non-queuing sections were determined from Curry and Anderson (see Figure 1) as a function of volume/capacity. The curve for 50 MPH AHS (design speed) was used. Speeds in the queuing sections were also determined from Curry and Anderson (see Figure 2).

In the second stage of the analysis, queue length was calculated as a function of difference in vehicles per mile within the queue, and vehicles

[1] David Curry and Dudley Anderson, Procedures for Estimating Highway User Cost, Air Pollution, and Noise Effects, NCHRP Report #133, 1972.

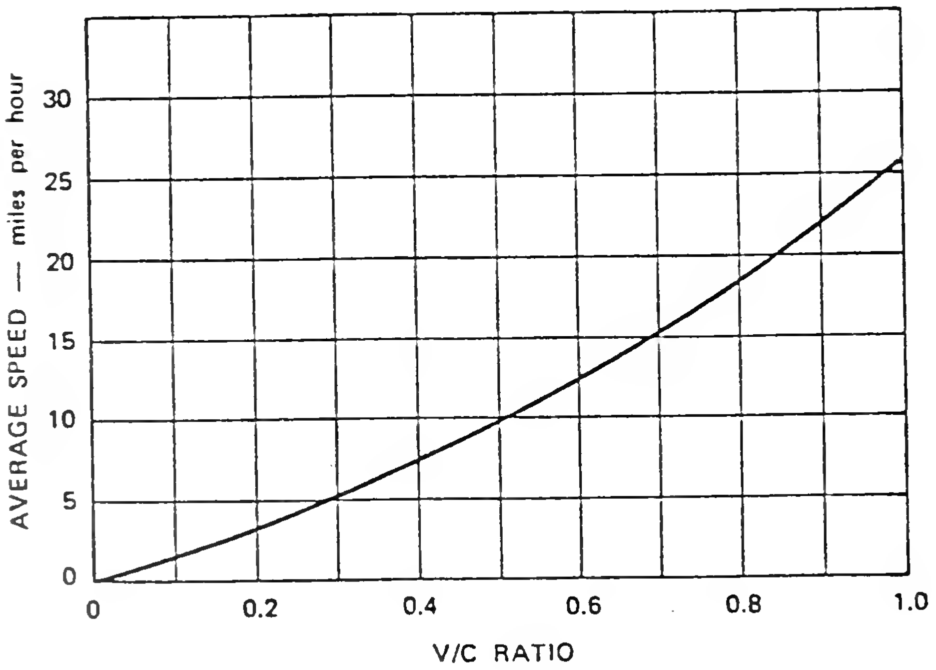
Figure 1: Running Speed, Freeways - Passenger Cars



Volume/Capacity Ratio

Source: NCHRP # 133, Figure A-1

Figure 2: Average Speed Versus Volume/Capacity Ratio for Level of Service F



Source: NCHRP #133, Figure 9

per mile upstream from the queue, as related to the number of peak period vehicles that could not pass through the bottleneck. Density of vehicles per mile in the highway sections was calculated by dividing the vehicles per hour by the vehicle speeds calculated earlier. The difference in vehicles per mile between the highway upstream from the queue, and the highway within the queue itself, represented the number of vehicles per mile that the queue section could accommodate by changing from non-queue to queue.

To determine maximum peak period length of queue, the following calculation was made:

Maximum Lane Miles of Queue =

$$\frac{\text{Hours in Peak x Vehicles per Hour to Enter Queue}}{\text{Number of Vehicles per Lane Mile that Queue can Accept}}$$

The average length of peak period lane miles of queue was the above-calculated figure divided by 2. To finally determine the average length of highway having a queue during the peak period, the average lane miles of queue were divided by the number of lanes in the section of highway affected.

South Area vehicle speeds and delays came directly from the queuing analysis. Area vehicle speeds for each alternative were determined by averaging the speeds in the different highway sections upstream of, within, and beyond the queue, with the averages weighted by the lengths of the sections involved. Delays were calculated from vehicle speeds. To do this, total travel times were calculated for each alternative by multiplying average speeds for the highway sections by the average demand, and adding together the results for the sections. These results were then normalized to base case volumes in order to allow comparability. Delay reductions were then the differences between total normalized travel times for the alternatives, and the total travel time that would prevail for the base or No Build case.

C. Travel Time Value and Savings

Travel time is one of the most important technical inputs for determining the extent, nature, and structure of transportation facilities. It is often the basis for selecting a particular routing of traffic, and is used in many trip allocation studies as a part of forecasting facility use.

For many years, it has been the practice in highway economy studies to price travel time in dollars. In most instances, the value of time has been determined either through inferring traveler values by analyzing their choices of modes or routes, or through studying wage rates. In this analysis both approaches have been used. For auto drivers, auto passengers, and bus passengers, time values were derived by using results from route and mode choice studies that were conducted in situations analogous to that of the Central Artery. A value of time for these classes of travelers was established at $4.30 per hour. For buses, commercial vehicles, and their drivers, information on non-distance related costs (e.g., insurance and depreciation) and on driver's wage rates was used. Time savings for both buses and commercial vehicles were valued at $10.00 per hour.

The actual determination of travel time value for auto occupants and bus passengers was based on methods and results from two studies, one by Thomas,[2] and the other by Lisco.[3] These studies were conducted under highly selected conditions that were related in several ways to those in the South Area. First, the values derived applied solely to urban peak-period commuting. Second, the values related only to persons on their home-to-work or work-to-home journeys. Also, they applied to middle to upper-middle class suburbanites. The values of the two studies were developed in 1966 and 1967, respectively.

Thomas offers the only important route choice contribution in the area of revealed commuter behavior. His research, based on driver

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2 T.C. Thomas, The Value of Time for Passenger Cars, An Experimental Study of Commuters' Values, Vol. II of a report prepared by Stanford Research Institute for the U.S. Bureau of Public Roads, May, 1967.

3 Thomas Lisco, The Value of Commuters' Travel Time - A Study in Urban Transportation, doctoral dissertation, University of Chicago, June, 1967.

behavior in eight cities, recommended a commuting time value of $2.80 per hour. Lisco, whose analysis was conducted in the Chicago area, used a mathematical model similar to that used in the Thomas study. His data, however, came from a sample of commuters who faced a trade-off situation between automobiles and public transit. The Lisco study arrived at a time value of $2.50 per hour.

Although the results of either of these two studies could have been adjusted, updated and applied to the Central Artery situation with little difference in the overall outcome, the Lisco results were actually used. This was partly because the Lisco study involved both auto and transit users, and partly because it allowed simple adjustments for use in the Boston area. In order to apply the Chicago results to Boston, two corrections were necessary. These were to reflect the fact that time value correlates closely with income, and to account for inflationary changes. The first correction was an adjustment to make Chicago time values in 1967 comparable to those in Boston at that time. To do this, the Chicago value of $2.50 per hour was lowered to $2.45 for Boston to account for the approximate 2% difference in median incomes between Illinois and Massachusetts that prevailed in 1967. The second correction was to adjust for inflationary and real income changes in Massachusetts between 1967 and 1975. This involved a simple projection of the 1967 Boston value to 1975 using a ratio of 1975 to 1967 Massachusetts median incomes.[4] This yielded the final time value of $4.30 per hour for auto occupants and bus passengers.

To determine the value of travel time savings for trucks and buses, values developed by Adkins, Ward, and McFarland were utilized.[5] Based on data published by the U.S. Department of Labor, Bureau of Labor Statistics, the

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4 "Money Income and Poverty Status of Families and Persons in the United States: 1975 Revisions (Advance Report)," U.S. Department of Commerce, Bureau of the Census - Series P-06 #103, issued Sept., 1976.

5 W.G. Adkins, W.W. Allen, and W.F. McFarland, Values of Time Savings of Commercial Vehicles, NCHRP Report #33, 1967.

authors compared vehicle interest, depreciation, and taxes on an hourly basis to establish the values of vehicle time for commercial vehicles throughout various regions of the U.S. Then they added to these values, driver's wages, welfare, workmen's compensation, and FICA taxes. The total hourly costs for trucks in the New England area in 1965 came to $4.89 per hour, and those for buses to $4.97. Using changes in price indices and recent U.S. Department of Labor statistics[6], these figures were updated in the South Area Study, respectively, to $9,90 per hour for trucks and $10.00 per hour for buses. For purposes of measuring South Area benefits, both figures were assumed to be $10.00 per hour.

To apply the calculated time values, it was necessary to determine the appropriate volumes of passengers and vehicles. To apply the time value savings of auto occupants, information was necessary on auto occupancy. For this purpose, counts were taken by the MDPW during the morning peak period both in the North Area of the Central Artery, and at Southampton Street on the Southeast Expressway. The average auto occupancy for the North Area was estimated at 1.40 passengers per vehicle, and at Southampton Street, the estimate was 1.30. Thus, for purposes of calculating travel time benefits for the South Area, an average peak period auto occupancy of 1.35 was assumed.

Based on bus counts taken as part of the Southeast Expressway Downtown Express Lane evaluation program, total numbers of buses were estimated. The average peak period occupancy rate was assumed to be 40 passengers per bus. The analysis did not assume any sort of preferential lane for buses in the South or Central Areas.

Finally, it was necessary to determine the total number of trucks. This figure was taken from the same sources used in the traffic estimation procedure. Trucks were estimated at 3.5% of total traffic volumes.

In estimating the values of total time savings associated with the various alternatives, a conservative approach was used. Benefits were calculated only for the AM and PM two hour peak periods for the 260 workdays per year, and only

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6 Bulletin #1917, U.S. Department of Labor, Bureau of Labor Statistics.

for users of the South Area section of the Central Artery. As in the case of the delay analyses, benefits from implementation of proposed improvements elsewhere in the corridor were included only insofar as they would be experienced in the South Area. Benefits to travel on local streets were not included.

D. Vehicle Operating Cost Savings

Exclusive of travel time and accident costs, operating costs of a vehicle when on the highway consist of fuel, oil, tires, depreciation, and maintenance. Other costs, such as license fees, insurance, parking fees, tolls, garage rental, and interest charges are not closely related to design of a highway or to traffic conditions, and thus can be omitted from economic analysis of highway options.

A review of the literature revealed three major sources of information on vehicle operating costs in the U.S.: Winfrey,[7] Claffey,[8] and Curry and Anderson.[9] Since Curry and Anderson utilized the work of Winfrey and Claffey, and also allowed straight-forward application, the Curry and Anderson work was used to develop South Area operating costs.

The actual procedure for calculating operating costs had two parts and was done separately for automobiles and trucks. In the first part of the analysis, base case operating costs were developed. These assumed the present level of service "F" prevailing on the South Section of the Central Artery during peak periods, and included an inflation factor to cover cost increases from 1970, the year of the Curry and Anderson cost indices, to 1975. In the second part of the analysis, operating costs for the various alternatives were related to operating speeds, again with the given inflation factor. The following sections describe the specific procedures used, respectively, for automobiles and trucks.

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7 Robley Winfrey, Economic Analysis for Highways, (International Textbook Company, 1969).

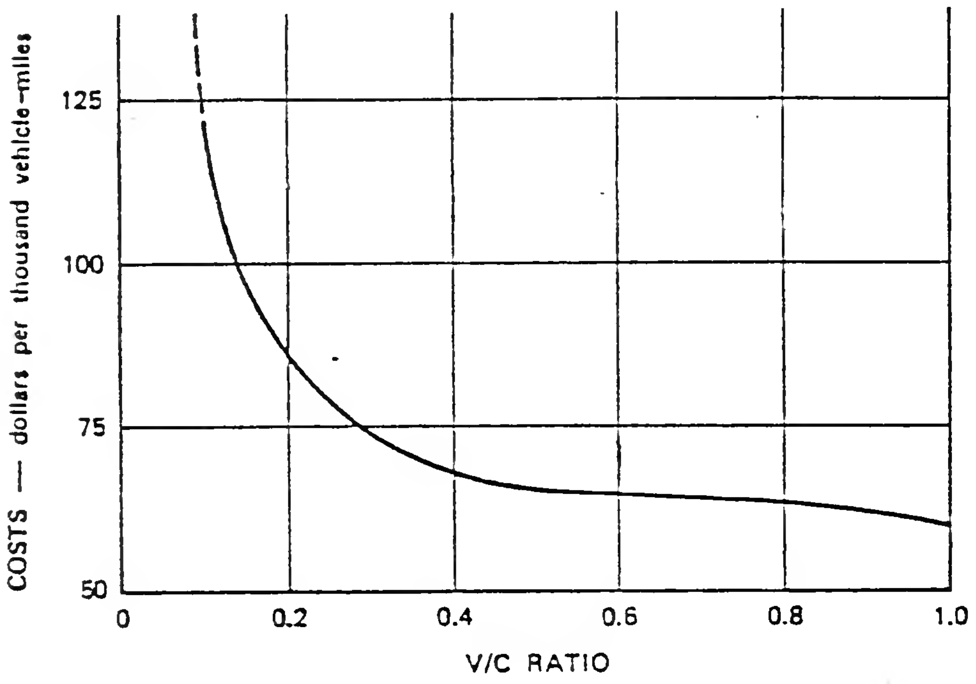
8 Paul Claffey, Running Costs of Motor Vehicles as Affected by Road Design and Traffic, NCHRP Report #111, 1971.

9 Curry and Anderson, loc. cit.

1. Automobile Operating Costs

Base case operating costs for automobiles came directly from Curry and Anderson. Figure 3 shows automobile operating costs as a function of Volume/Capacity (V/C) ratio for level of service "F". As can be seen, costs per 1,000 vehicle miles drop rapidly until a V/C ratio of about .4, and then remain relatively stable after that. Assuming a V/C ratio of .8, (which probably yields a conservative estimate of automobile operating cost on the Artery), this would imply a base automobile operating cost in 1970 of $62.00 per 1,000 vehicle miles.

Figure 3: Automobile Operating Cost Versus Volume/Capacity Ratio for Level of Service F



Source: NCHRP # 133, Figure 13

To provide an appropriate inflation factor from the 1970 Curry and Anderson costs, an analysis was undertaken of the individual cost components of automobile operation. Analysis by the MDPW revealed increases in the costs of individual items ranging from 25% to 91%. These are shown in Figure 4. Based on the various component costs and cost increases, a conservative estimate was made that overall automobile operating costs increased 35% between 1970 and 1975. Applying

Figure 4: Road User Costs for Passenger Vehicles 1970 and 1975

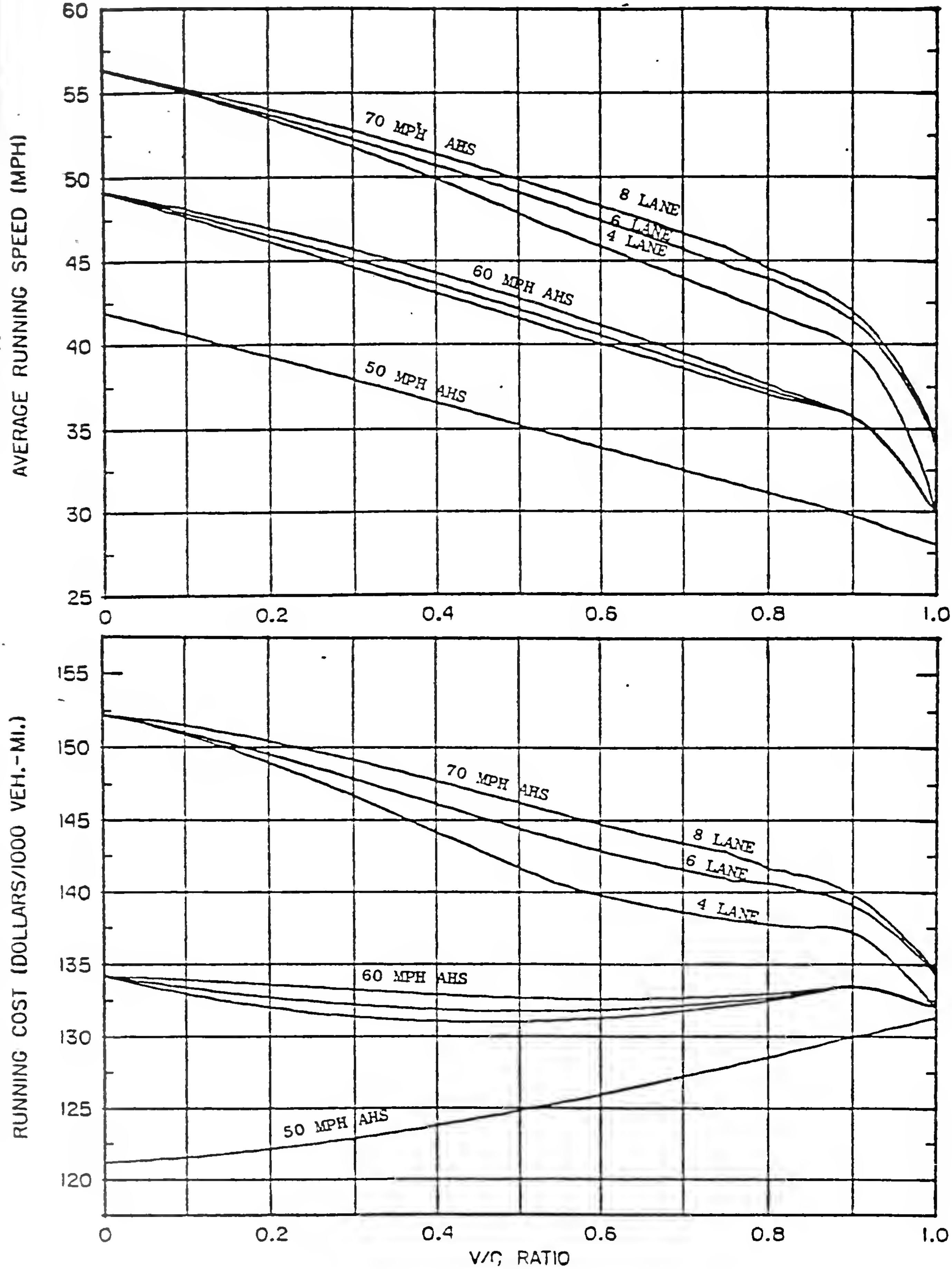
Cost Item	Unit Price or Factor for Passenger Cars		Percent Increase Over 1970
	1970[1]	1975[2]	
Fuel ($/gallon excluding tax)	0.24	0.46	91
Engine Oil ($/quart)	0.72	1.00	39
Tires ($/tire)	30.00	40.00	33
Depreciation (Vehicle base price)	3400.00	4200.00	23
Maintenance			25

Source: 1 NCHRP #133
2 MDPW staff analysis

this to the $62.00 per 1,000 vehicle miles cost for 1970, yielded a base case cost of $83.70 for 1975.

Operating cost estimates for the various South Area Study alternatives came from the queuing analysis and from Curry and Anderson. As part of the queuing analysis, vehicle speeds and volumes were developed for each link of each alternative for peak period travel. The vehicle speeds were applied to Figure 5 (from Curry and Anderson) which relates vehicle speed to Volume/Capacity ratio, and Volume/Capacity ratio to operating cost. The 50 MPH Average Highway Speed (design speed) curves were used. Using the individual per mile operating costs derived from vehicle speeds, total automobile operating costs for each alternative were developed by multiplying the link per vehicle mile costs by the link vehicle miles, and then adding the totals together. After that, the 35% inflation factor was added, and a final 3.5% downward adjustment was made to reflect the fact that only 96.5% of peak period Central Artery traffic volume is automobiles. (3.5% is trucks)

Figure 5: Running Speeds and Costs for Passenger Cars on Freeways



Source: NCHRP #133, Figure A-1

2. Truck Operating Costs

The procedure for developing truck operating costs was analogous to that used for automobiles. Figure 6 shows truck operating costs at level of service "F". Assuming a V/C ratio of 0.8, this gives a 1970 operating cost for trucks of $245.00 per 1,000 vehicle miles. Individual components of truck operating costs are shown in Figure 7. As seen in the figure, truck operating cost components rose much more than those for automobiles during the period 1970-1975. The increases ranged from 35% to 525%. Based on the numbers shown in the figure and on the assumption that fuel was a major truck operating cost, it was conservatively estimated that overall truck operating costs rose 67% between 1970 and 1975. This yielded a 1975 base case truck operating cost of $410.50 per 1,000 vehicle miles.

To calculate total truck operating costs for the alternatives, link volumes and speeds were used as before, and applied to the 50 MPH AHS curves of Figure 8, which relates truck vehicle speeds to operating costs. The only difference here between the truck and automobile analyses was that for trucks the 67% inflation factor was used, and that calculations were based on the 3.5% fraction of total traffic volume that trucks represented.

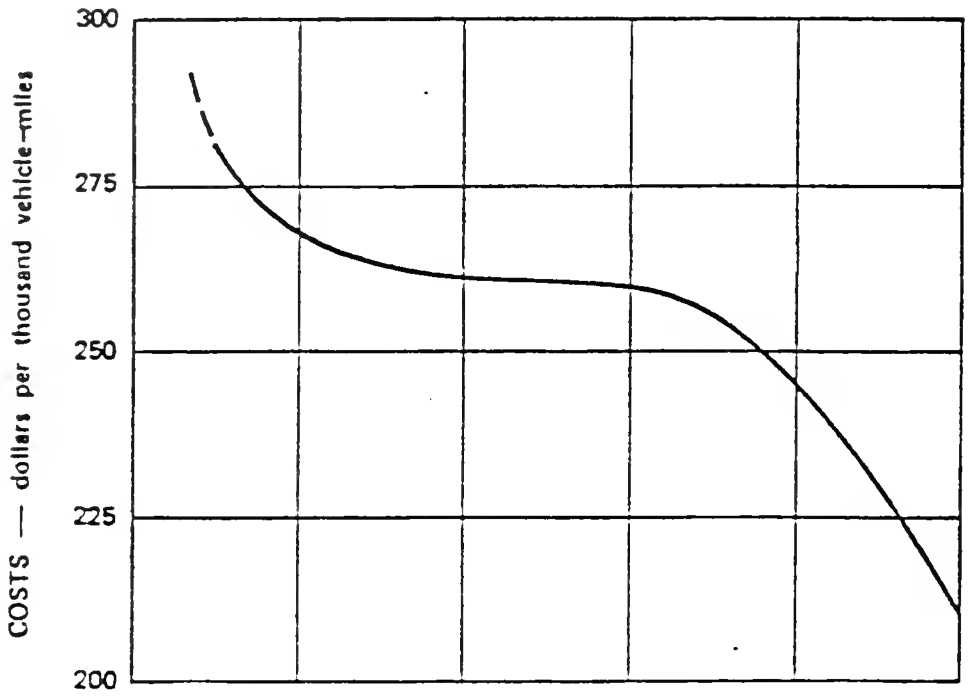
To complete the operating cost analysis, the results for trucks and for automobiles were added together for each of the alternatives. Cost savings were the difference in operating costs between the base case (No Build) costs and the calculated costs of the various alternatives.

III. DESIGN STANDARDS AND SAFETY

A. Accidents

A considerable body of research has demonstrated the close relationship between highway design standards and safety. In spite of extensive analysis, however, there still remains insufficient information to accurately predict future accident experience for many proposed facilities. In particular, while there are good sources of information to use in estimating accident reductions associated with minor spot improvements, research still falls short of making possible highly accurate predictions of accident reductions from major improvements to such complicated

Figure 6: Truck Operating Cost Versus Volume/Capacity Ratio for Level of Service F



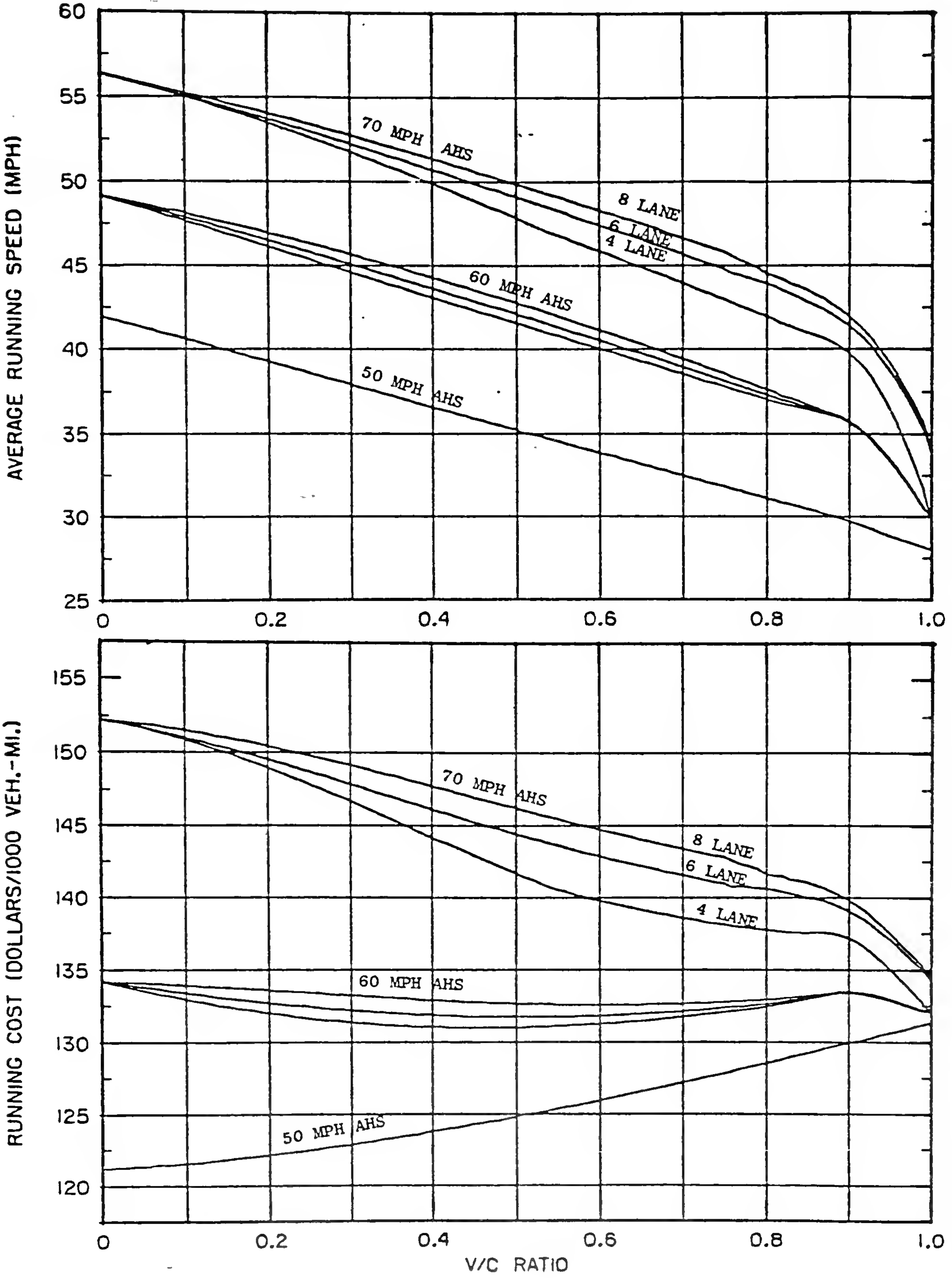
Source: NCHRP #133, Figure 13

Figure 7: Road User Costs for Commercial Vehicles 1970 and 1975

Cost Item	Unit Price or Factor for Trucks 1970[1]	1975[2]	Percent Increase Over 1970
Fuel ($/gallon excluding tax)	0.16	0.31	93
Engine Oil ($/quart)	0.20	1.25	525
Depreciation (Vehicle base price)	22,600.00	unknown	--
Maintenance			35

Source: 1 NCHRP #133
2 MDPW staff analysis

Figure 8: Running Speeds and Costs for Trucks on Freeways



Source: NCHRP # 133, Figure A-3

areas as the South Area of the Central Artery. As a result, predictive techniques to forecast probable accident reduction rates associated with South Area alternatives must be somewhat generalized.

In developing a method for projecting the Artery's future accident experience, two assumptions were made. The first was that it would be reasonable to assume that the excessive numbers of accidents on the Artery are caused at least in part by the combined total of its design problems. Second, it was assumed that the high volume of traffic relative to the capacity of the Artery facility, and particularly the amount of queuing, also contributes to the Artery's high accident rate. Reflecting these assumptions, a method for projecting future accidents was developed which depended both on the degree to which the improved Artery would conform with Urban Interstate design standards, and the degree to which future peak period queues would be eliminated.

Specifically, the method initially assumed that the accident rate on portions of the improved Artery that met Urban Interstate design standards would drop from that of the present facility to the average rate for Urban Interstate facilities in Massachusetts for 1975 (1.34 accidents per million vehicle miles of travel). Portions not brought into conformance with Urban Interstate standards would have an accident experience the same as that prevailing in the South Area of the Artery in 1975. The initial future accident rate calculation was based on the number of miles of future South Area facility that would conform to Urban Interstate standards as a fraction of total miles of the South Area facility. Accidents were projected based on vehicle miles and on the normalized link volumes derived in the traffic assignments for the alternatives.

In the second state of the accident projection technique, it was assumed that the initially projected future reductions in accident rates would be achieved only in proportion to the degree to which queues were reduced. If a particular alternative had no queue reduction (e.g., the No Build Alternative in the northbound direction), no accident reduction would take place. If the alternative completely removed the queue, it would yeild all the accident reduction benefits that its conformance with Urban Interstate Design would allow. If it were associated with partial elimination of the queue, the accident reduction would be in proportion to the length of queue eliminated as a fraction of the total "No Build" queue.

As a practical matter, the two-stage analysis of potential accident reduction was carried out in its entirety only for the northbound roadway. Since there is no queue southbound on the South Section of the Artery, southbound accidents were projected based on the proportion of South Area Artery accidents occurring on the southbound lanes during 1975, and on the degree to which Urban Interstate design standards would be met in the reconstructed facility. Northbound, the analysis depended on the fraction of northbound accidents in 1975, on the proportion of improved facility that would meet Urban Interstate standards, and on queue reduction.

In the accident analysis, accidents by subcategories were projected based on their relative frequencies in 1975. No attempt was made to project accidents on local streets in the South Area. It is expected that improved signal systems coupled with proper channelization and more standardized geometrics will greatly improve safety on local streets. Quantification of the safety results of these improvements must wait until the design alternatives are planned.

B. Accident Costs

Associated with accidents are substantial costs, not only for injuries and deaths, but also for property damage. As with time savings, it has long been the practice of calculating accident loses in dollar values. Considerable literature has attempted to evaluate the costs of accidents, particularly those involving injuries and fatalities. In this literature, one of the most comprehensive studies was conducted by the National Highway Traffic Safety Administration of the U.S. Department of Transportation, in 1972.[10] This study developed societal costs for traffic injuries and deaths for the base year, 1971. The estimated societal costs included both lost wages and additional services required because of accidents. Lost

10 Societal Costs of Motor Vehicle Accidents, Preliminary Report, National Highway Traffic Safety Administration. U.S. Department of Transportation, 1972.

wages were of the persons directly affected; services were for hospital costs, funeral costs, and the like. The NHTSA study established the societal cost of a traffic fatality at $200,000, and that of an average accident injury at $7,300.

A subsequent study by the NHTSA and the Transportation Systems Center of the U.S.D.O.T. updated the 1971 costs to 1974.[11] This was done by multiplying the proportion of total 1971 cost that was due to service costs, similarly compounded over the three years by service cost increase factors. The resulting total increase factor was then applied to the 1971 costs.

The specific formulas used for these calculations were as follows:

$$L_{D74} = L_{D71} \left[W_{D71}(1+\Delta W_{71})(1+\Delta W_{72})(1+\Delta W_{73}) + S_{D71}(1+\Delta S_{71})(1+\Delta S_{72})(1+\Delta S_{73}) \right]$$

and

$$L_{I74} = L_{I71} \left[W_{I71}(1+\Delta W_{71})(1+\Delta W_{72})(1+\Delta W_{73}) + S_{I71}(1+\Delta S_{71})(1+\Delta S_{72})(1+\Delta S_{73}) \right]$$

where

L_{D74} Societal cost of a death in 1974.

L_{D71} Societal cost of a death in 1971.

W_{D71} Fraction of total societal cost of a death in 1971 due to lost wages.

ΔW_{7i} Wage increase factor for given year in terms of rate of wage increases experienced during that year.

S_{D71} Fraction of total societal cost of a death in 1971 due to service costs.

ΔS_{7i} Service cost increase factor for given year in terms of rate of service cost increases experienced during that year.

L_{I74} Societal cost of an average injury in 1974.

L_{I71} Societal cost of an average injury in 1971.

11 Analysis of Effects of Proposed Changes to Passenger Car Requirements of MYSS208 , NHTSA and Transportation Systems Center, U.S. Dept. of Transportation, August, 1974.

W_{I71} Fraction of total societal cost of an injury in 1971 due to lost wages.

S_{I71} Fraction of total societal cost of an injury in 1971 due to costs of services.

Using these formulae, the 1974 study calculated the updated cost of a traffic fatality at $242,000, and the cost of an injury at $8,500.

To further update the NHTSA results to 1975 for use in the South Area analysis, an analogous procedure to that described above was used. The respective wage cost proportions of total costs for the 1974 base were .677 for traffic fatalities and .178 for injuries. Correspondingly, the service cost proportions were .323 and .822 for fatalities and injuries, respectively. A wage cost increase of .08 was used for increases in wages during 1974, and a service cost increase factor of .05 was used for increases in the costs of services. From this second updating, the total cost of a traffic death in 1975 was estimated at $259,000, and that of a traffic injury at $9,000.

With societal costs of traffic injuries and fatalities established, it was necessary only to determine average property damage costs for accidents. These were estimated at $550 per accident based on a $500 figure developed by the National Safety Council for 1974, escalated by 10% to 1975.

To calculate accident cost savings for the South Area alternatives, the accident fatality, injury, and property damage costs discussed above were applied to the accident rates calculated for the alternatives. It was assumed that fatalities and injuries would occur in the same proportions in the alternatives as they did in the South Area of the Artery during 1975.

IV. ENVIRONMENTAL AND COMMUNITY IMPACTS

The South Area Study text considers five areas of environmental and community quality that might be affected by potential South Area construction: air quality, noise, water quality, tax base and development, and community quality and character. Two of these, water quality, and community quality and character, are treated fully in the text, and require no further consideration here. The others are taken up below.

A. Air Quality

The air quality section of the South Area text is intended to provide a basis for Environmental Impact Statement level studies of air quality impact, and to highlight important air quality issues for further consideration. In line with the level of detail contained in the preliminary traffic and other studies, a somewhat simplified calculation of air quality indices was used.

The analysis presented in the air quality section was a determination of gross pollutant emissions, in tons of pollutants per year, generated by traffic only on the Artery under the various alternatives considered. In order to carry out this analysis, total vehicle miles of travel on the South Section of the Artery and on all ramps were taken from the traffic assignments for the alternatives. Estimated 1975 peak hour volumes on all links for all alternatives were used to synthesize total annual vehicle miles of travel. Peak hour speed assumptions from the traffic analysis were used for all links, so that reported estimates of CO and HC pollutant burden are conservative. The NO_x totals are probably under-estimated, since NO_x emission factors increase as speed increases.

All VMT totals computed were based on 1975 travel. To correspond with this, the emissions factors used to calculate gross emissions were 1975 average emission factors taken from Environmental Protection Agency documentation.[12] These factors were speed-corrected for assumed operating speeds for each link of the Artery South Section using correction formulae for light duty gasoline powered vehicles at low altitudes.[13] The resulting emissions factors for different speeds are shown in Figure 9.

B. Noise

Two approaches were used to estimate likely major noise impacts of proposed South Area changes to the Central Artery. First, field observations were conducted along the Artery route in the South Area. Their purposes were to identify noise-

12 Compilation of Air Pollution Emission Factors (AP 42), Supplement 5, Environmental Protection Agency, 1975, Table D.8-1.

13 *Ibid.*, Tables D.1-23 and D.1-24.

sensitive land uses affected by the South Section of the Artery, to locate important noise generators other than the Artery itself, and to supplement the information obtained from earlier South Terminal and Central Artery data collection efforts. The second procedure was a trial use of the noise prediction method described in NCHRP #117, Highway Noise, A Design Guide for Highway Engineers.[14]

Field observations of the South Area of the Artery Corridor yielded a number of conclusions. Primary among these was the fact that the Artery itself is not the predominent noise generator in the South Area. As such, it adds only marginally to existing Area noise levels. Thus, potential Artery changes could alter the noise levels in the South Area only to a minor degree. The detailed conclusions from the field observations are discussed more fully in the South Area Study text.

Figure 9: Speed Corrected Average Emissions Factors

1975 Base CO = 61.10 (Grams per Vehicle Mile)
1975 Base HC = 8.80
1975 Base NO_x = 4.80

AVG. SPEED (M.P.H.)	CO	HC	NO_x
5.0	253.56	24.20	5.52
10.0	136.25	14.34	4.94
12.0	136.25	14.34	4.94
15.0	78.46	10.56	12.58
16.0	74.16	10.13	12.68
20.0	59.93	8.68	13.10
21.7	55.06	8.17	13.28
25.0	47.19	7.33	13.63
27.2	42.89	6.87	13.88
28.0	41.49	6.72	13.97
30.0	38.31	6.37	14.19
30.8	37.15	6.25	14.29
34.1	33.03	5.80	14.67
35.0	32.06	5.70	14.78
38.0	29.23	5.40	15.14
40.0	27.66	5.24	15.38

14 Colin Gordon, et.al., Highway Noise, A Design Guide for Highway Engineers, NCHRP Report #117, 1971.

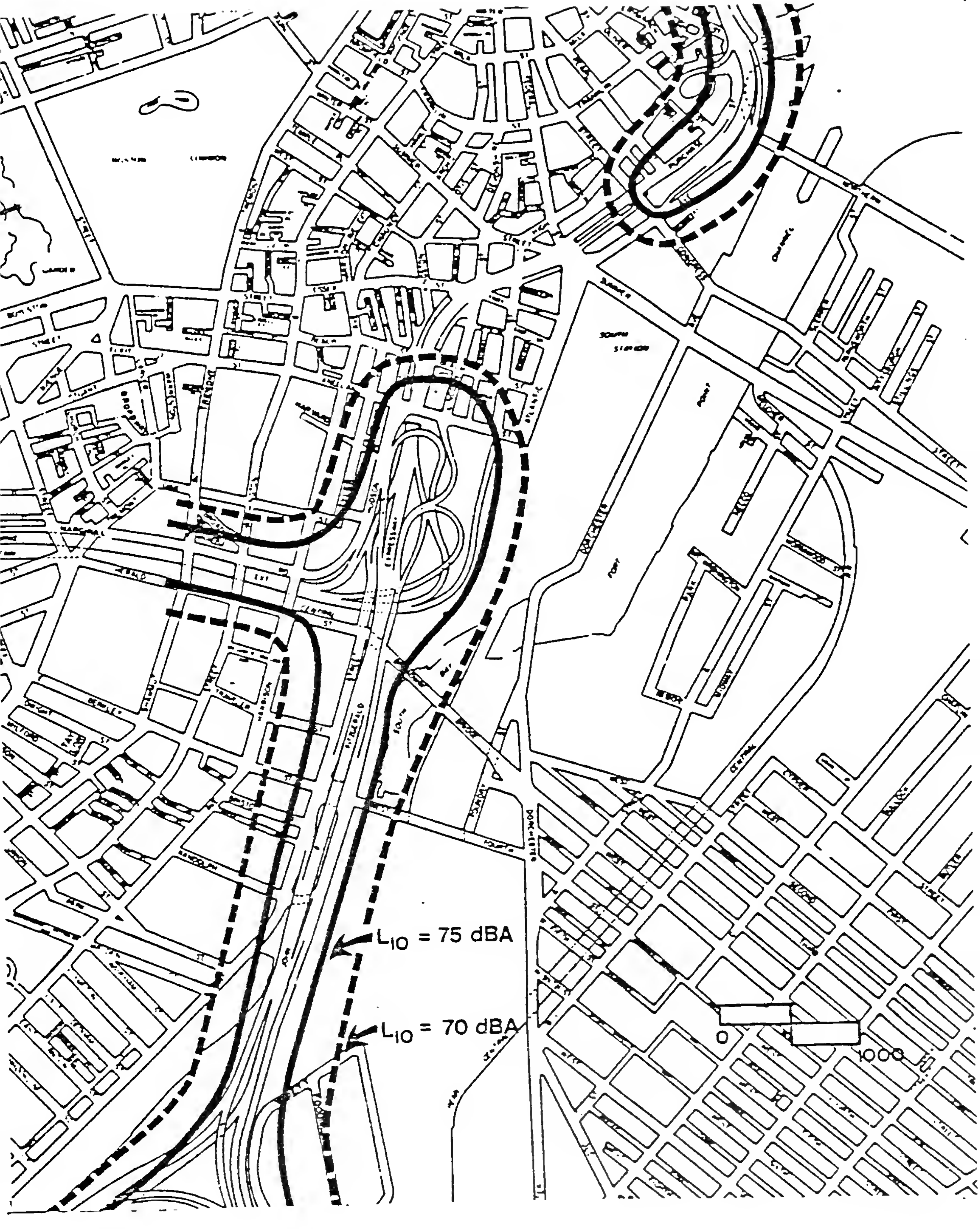
The second procedure, from NCHRP #117, used a mathematical model to simulate noise levels. The model used is most accurate in relatively undeveloped areas, where a proposed highway will represent the dominent noise source in the area it traverses. It is less useful in an urban situation for two reasons. First, it predicts the sound level generated only by the highways and/or streets modeled. These may not represent the dominent noise sources in their areas during all hours, or even large portions of the day. Second, it generally has limited success in accounting for the complex shielding and reverberation effects which are characteristic of sound propagation in urban settings.

Nonetheless, it seemed appropriate at the Corridor Planning Study stage to undertake a trial application of the model. For this application, shielding effects (other than those created by variations in the Artery profile) and complex sound propagation paths were ignored. In addition, traffic on local streets was omitted.

The assumptions used in applying the NCHRP #117 model were as follows: 1. Traffic volumes were modeled only for Alternative 1 (No Build) and Alternative 9 (Maximum Build-Central Area plus Split Alignment in the South Area plus general purpose Third Harbor Crossing). Only Artery volumes were considered, and of these, only those prevailing during the peak period were used. 2. Traffic speeds and volumes were those from the traffic analyses described earlier. Link speeds ranging from 10 to 40 MPH were estimated for all mainline links; ramp speeds ranged from 5 to 15 MPH. 3. The truck percentage for the Artery during peak periods was assumed to be 3.5%. 4. An observer height of six feet was used.

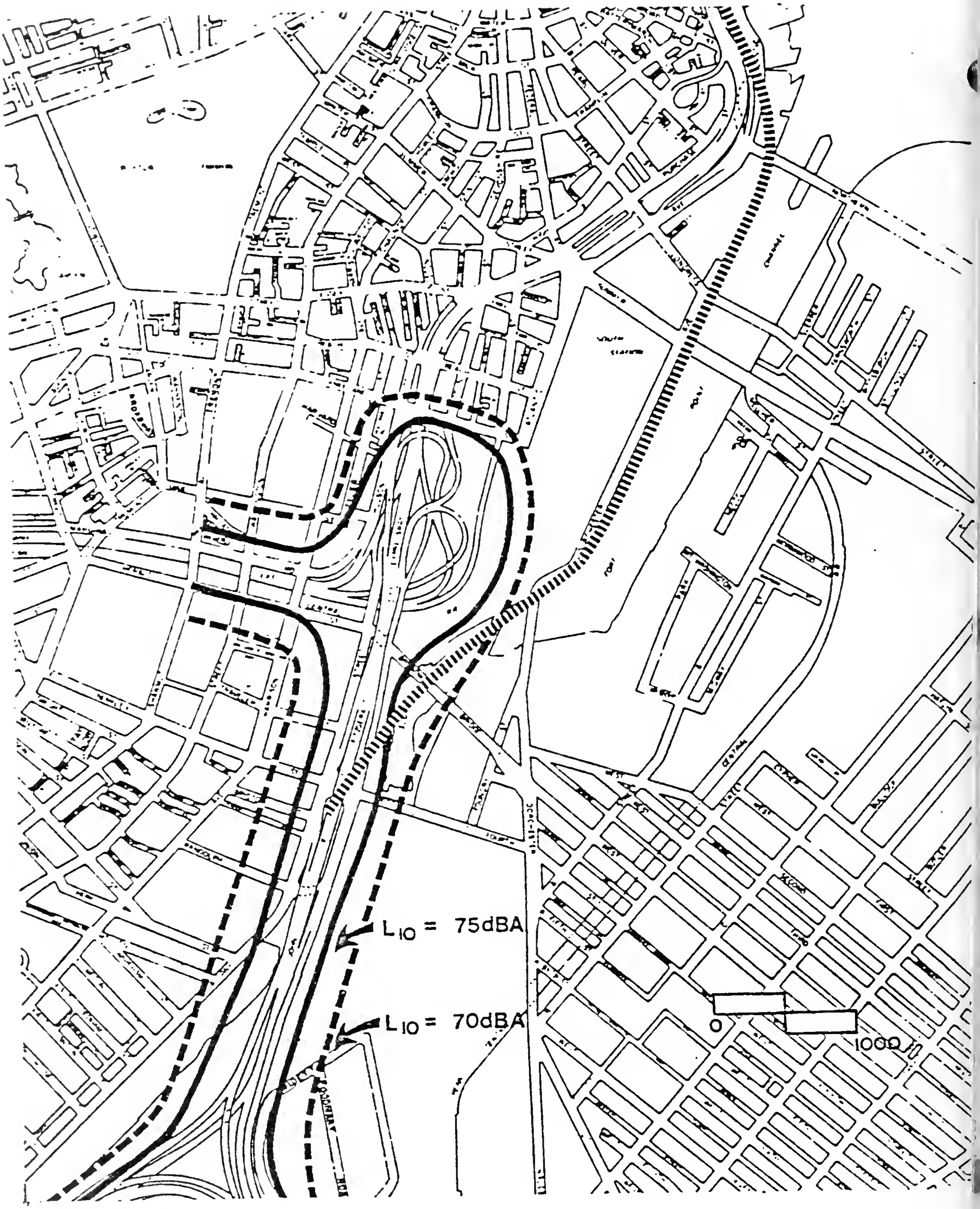
Figures 10 and 11 depict the resultant generalized contours representing equivalent Artery-generated L10 noise levels for Alternatives 1 and 9, respectively. The L10 = 75 dBA and L10 = 70 dBA values shown were selected for reasons as follows:

- L10 - 75 dBA. This line was presented because it represents the exterior Design Noise Level for commercial and industrial land uses appropriate to much of the South Area. The line defines what may be



EQUIVALENT ARTERY-GENERATED L_{10} NOISE LEVELS
EXISTING CASE

Figure 10



EQUIVALENT ARTERY-GENERATED L_{10} NOISE LEVELS
MAXIMUM BUILD ALTERNATIVE

Figure

considered as a "primary impact zone," within which the Artery itself, generates noise levels which exceed the Federal Highway Design Noise Level, regardless of the contributions of other nearby sources.

- L10 = 70 dBA. This line represents the Federal Highway Design Noise Level for residences, hotels, schools, recreation areas; land uses which have some representation in the South Area. As before, the line denotes a "primary impact zone" within which Artery-generated noise levels exceed the Design Noise Level for the appropriate land uses.

As can be seen in the figures, the results of the noise modeling generally supported the conclusions from the field analyses. Only within the right-of-way of the Artery itself, were simulated noise levels substantially above background levels prevailing generally in the South Area. Thus, the contours shown could not really demonstrate the Area noise environment either for the present or with future construction. For this reason, further noise simulation was relegated to the design stages of the South Area project, where detailed noise analysis will be undertaken. Such analysis will incorporate design and building environment details as well as other contributors to background noise levels.

C. Land Development and Tax Base

In the South Area Study analysis, land development potential was determined both in terms of land area that would be newly available for development after Central Artery construction, and in terms of the value of that land. Tax base impact was not calculated directly, but was projected in general terms based on the possibilities for new development.

New land potentially available for development was primarily the area above any newly depressed facility. The value of the new land was calculated by multiplying the number of square feet available by the market value of such land. This market value was determined by analyzing recent sales prices. For this purpose, two types of land uses were analyzed: low intensity and high intensity. For low intensity purposes, land was found to have a value of $32.31 per square foot; for high intensity, the value was $66.14. It was assumed that any new construction would probably be a mixture of low and high intensity development. Thus, actual land values would be somewhere between the low intensity and high intensity figures. It was also assumed that even if developable land were left as open space, that land would nonetheless retain its development value.

In the analysis of land value and tax base, two potential impacts were not included. One was the loss that would be associated with taking the Sheraton Building (necessary in Alternatives 4-9). That building had a 1977 assessed valuation of $6.45 million. The other impact neglected was the general increase in property values that would take place in the Artery Corridor once the negative impacts of the Artery were removed.

V. CONSTRUCTION COSTS AND IMPACTS

Construction costs for the South Area alternatives were developed by the MDPW as part of the 1977 Interstate Cost Estimate. As such, they were based on cost indices that prevailed during 1975.

In the cost estimation procedure, costs were first estimated for typical sections of construction involved, e.g. tunnel, viaduct, ramps; and for normal accompanying structures and equipment such as signing, lighting, and ventilation. Quantities of materials were usually calculated on a lineal foot or unit basis. Costs for individual items of work were generally developed from bid costs for construction within the Boston metropolitan area.

In applying the standard cost indices to the alternatives, estimates were made of the lineal feet or the numbers of units of the various types of construction in each alternative. These estimates were then applied directly to the per lineal foot and unit costs calculated earlier.

In all cost estimation, demolition costs were included as appropriate. It was assumed that the materials in demolished structures would have a zero net value.

Two types of construction impacts were considered in the South Area analysis: construction duration and traffic disruption. Construction duration was estimated based on the experience of the MDPW in earlier highway construction projects. Potential traffic disruption associated with the alternatives was broadly estimated based on staging requirements and the nature of construction.

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